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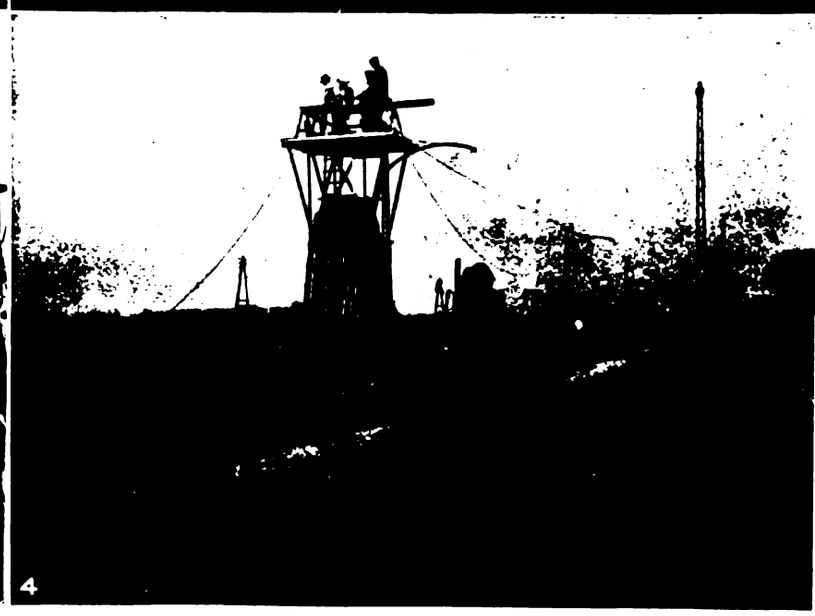

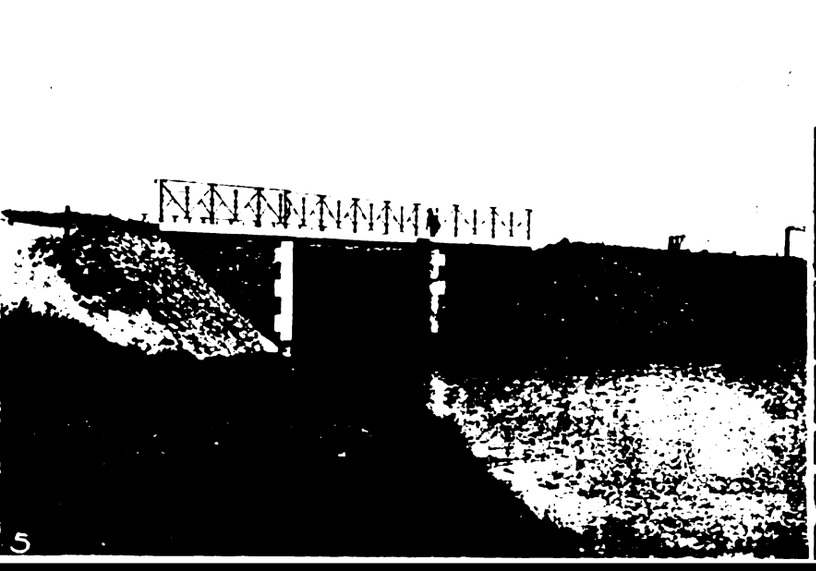

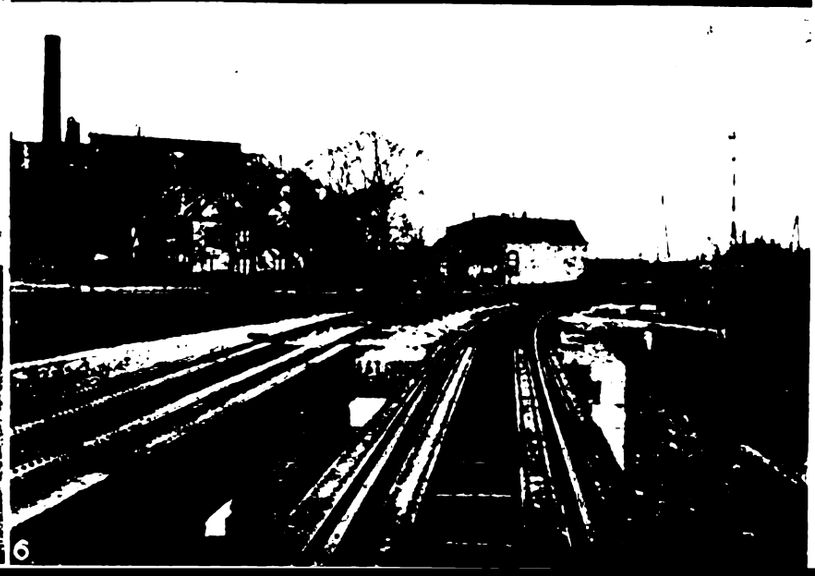

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THE TRAMWAY AND RAILWAY WORLD

A REVIEW OF RAILWAY AND TRAMWAY PROGRESS

IN

ELECTRIC AND OTHER TRACTION

Index to Volume XVII

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THE Tramway & Railway World
A REVIEW OF CURRENT PROGRESS IN ELECTRIC AND OTHER TRACTION

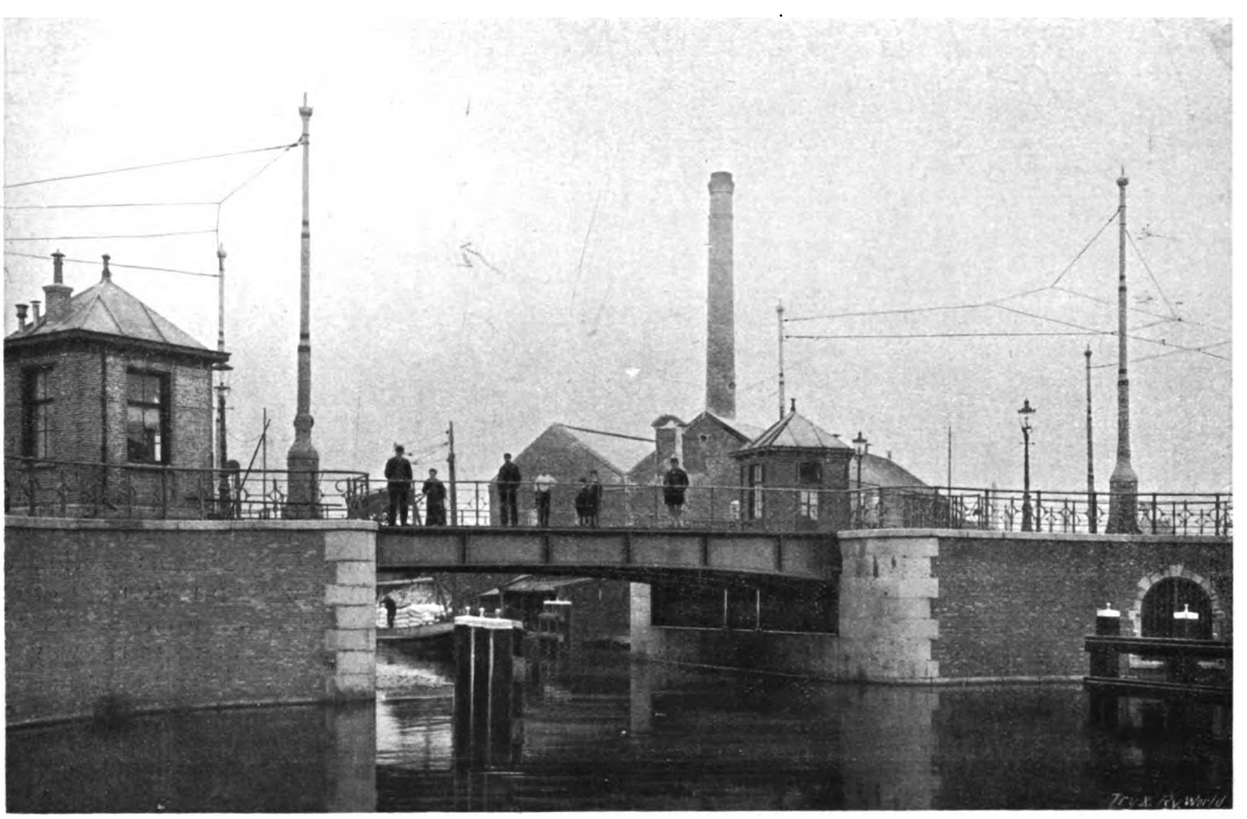
VOL. XVII. LONDON, JANUARY 12, 1905. VOL. XVII.

AMSTERDAM-HAARLEM ELECTRIC RAILWAY.

A HIGH-SPEED LINE IN HOLLAND.

In our issue of December 8 last we mentioned that through the courtesy of J. G. White and Company, Limited, representatives of the technical press were given an opportunity of carefully inspecting the new electric railway which has been built from Amsterdam to Haarlem, with an acquired extension to Zandvoort, and the whole plant and equipment. With the assistance of the same firm, who were the contractors for the whole undertaking, we are now enabled to present a full and illustrated description of the installation, which is unique in Holland, and perhaps not exactly paralleled elsewhere in the world.

About five years ago a local Dutch company constructed in Haarlem the first electric tramway system in Holland. This system included a circular route about the city, with two suburban branches, one running north to Bloemendal, a thriving residential suburb, and another west about five miles to Zandvoort, an important seaside resort for the people both of Haarlem and of Amsterdam.



Bascule Bridge at Kostverloren Vaart, with Gap in Trolley Wires.

Haarlem itself is a city of 65,000 inhabitants and a very pleasant residential place, where many of the business men of Amsterdam live. The distance between the boundaries of the two cities is ten miles. Several years ago a concession was granted for a line between the two towns, but the route was circuitous, and finally the Holland Steam Railway Company secured control and prevented the construction

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of the line. In 1901, however, Messrs. Anderhagen and Neumeyer, of Amsterdam, took the preliminary steps towards securing a new concession over the direct Government high road connecting the two cities and running parallel with the steam railway.

The essential conditions of this concession for the construction of a double line with one track on each side of the Government high road were:

(1) The concessionaire was required to sheet-pile the sides of the road (which is bordered by a canal on one side and a ditch on the other) in order to secure the necessary width and stability, and to carry out the whole of the works with the least possible interference with the regular use of the road.

(2) The period of the concession was for 50 years from December 31, 1902.

(3) All construction plans were required to be submitted for the Government approval.

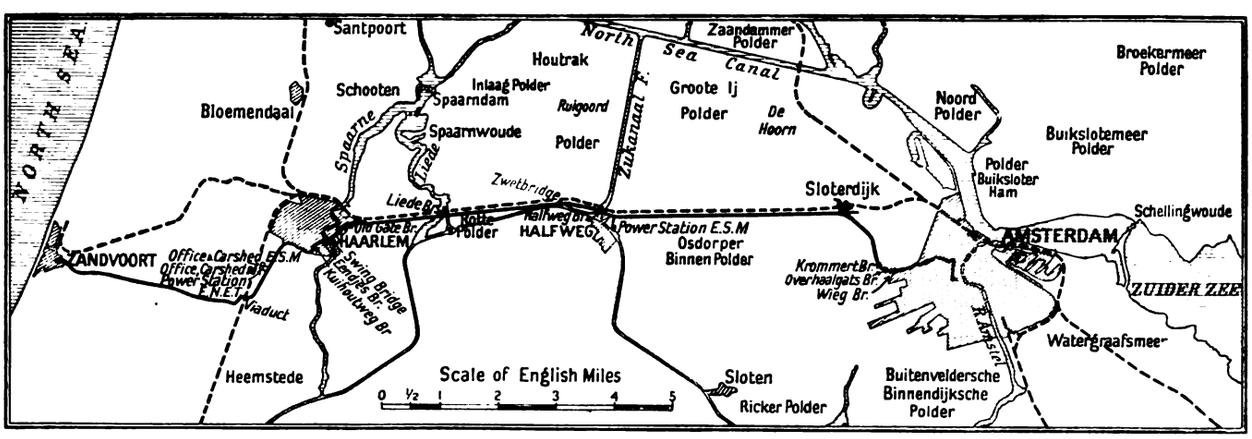
(4) The period allowed for the construction was two years.

(5) The speed allowed for the cars was to be regulated by the Secretary of State, and the speed actually permitted was 35 kilometres (21¾ miles) per hour. The Secretary of State is also empowered to fix the maximum fares, but it was generally understood that the maximum fares allowed should be equal to those of the steam road.

In addition to this concession for the use of the Government high road, it was necessary to obtain an entrance into Amsterdam, and to do

Floating Bascule Bridge to Position.

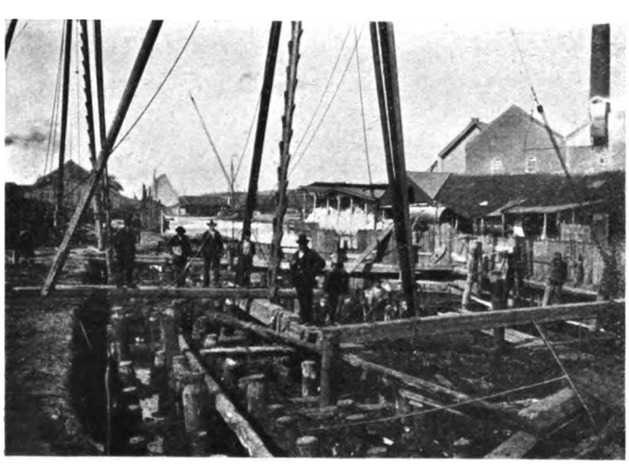
this satisfactorily the concessionaires obtained options on a private right of way for about two miles from the Government road to the Amster-



Map Showing Route of Railway.

(6) At the expiration of the concession the Government may take over, without compensation, all the property of the Company located on Government lands.

There are a large number of minor provisions regarding protection of working men as to hours



Bascule Bridge Excavations.

of labour, accident insurance, pensions, and so forth, and minor provisions as to the protection of the various water boards, drainage boards, telegraph companies, railways, etc.

dam city limits, at a point near the terminus of one of the Amsterdam Corporation Tramway lines. In obtaining this private right of way, the option was made to include a strip of land for the whole distance, wide enough to permit of a row of building lots on each side of the road being laid out and sold. On this section the tramway is built on a purely private right of way in the centre of the road, with a paved driveway on each side, and outside of this driveway the usual footpath and building lots are arranged.

Running powers were then secured over the tramways of Amsterdam, then in process of electrification, for a distance of about one mile from the city limits to the corner of the Spui and the Kalverstraat, the centre of the office and retail business districts of Amsterdam. The gauge of the Amsterdam city lines being standard, and the gauge called for by the new concession being one metre, it was necessary to lay a third rail for the greater part of this distance, where the lines are common, to permit through running of cars over the Corporation route. This work was carried out by the Corporation at cost plus a percentage. This was made more expensive by the fact that a large

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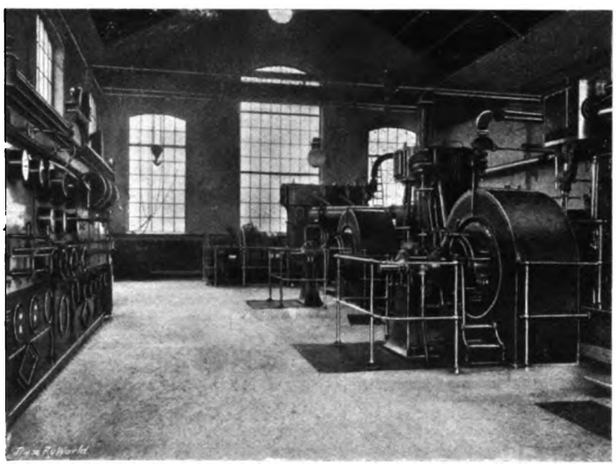
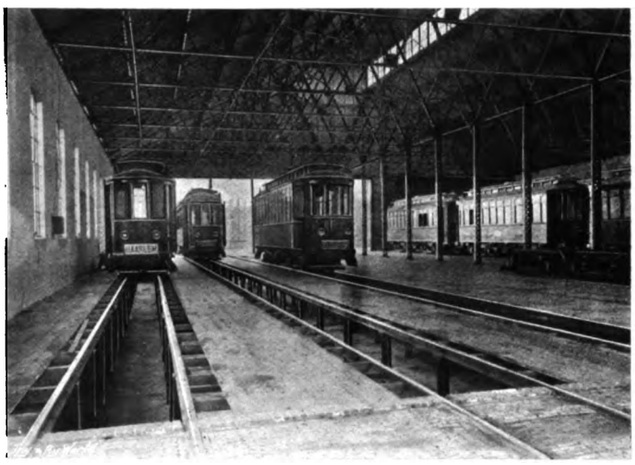
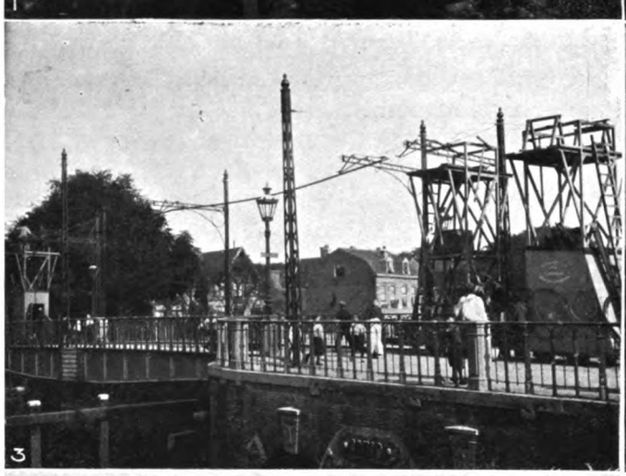
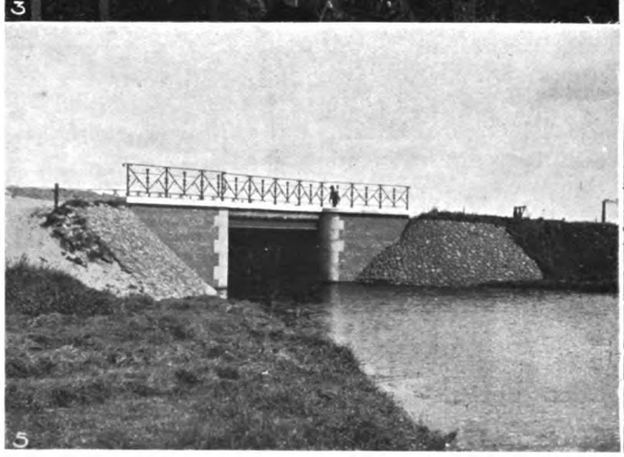


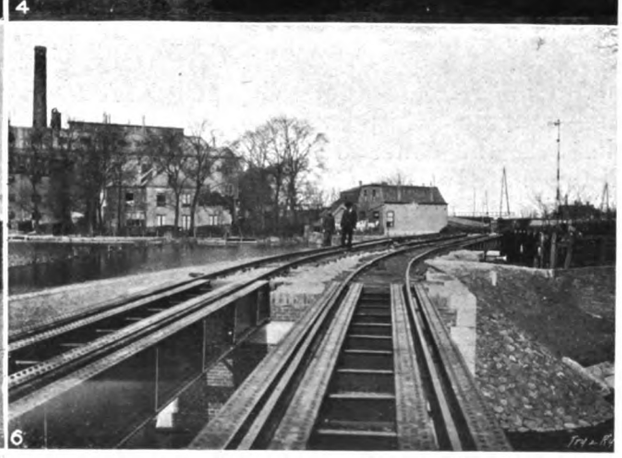
Interior of Haarlem Power-Station.



Interior of Car Shed, Haarlem.







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5. Bridge on Private Right of Way, Amsterdam.
6. New Bridge, Half-way to Haarlem.

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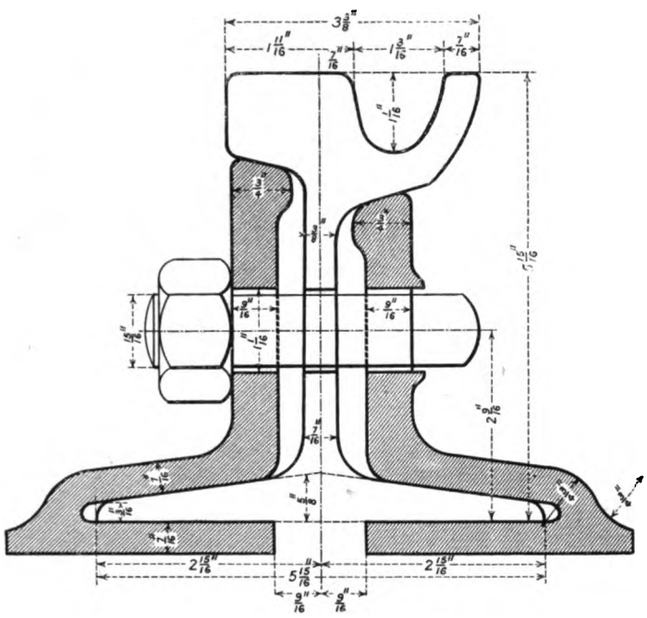
swing bridge had to be constructed, to permit the through running of the cars, and this was done principally at the expense of the concessionaires. In addition to paying for this bridge and construction, the concessionaires agreed to pay 40 per cent. of the fares which the town would have charged within the city limits, on the basis of its own rates, and also to repay the actual cost plus 10 per cent. expended by the Corporation for repairs and maintenance of the tracks used by the concessionaires, and, further, to pay for power within the city taken from the city's trolley wires, at a rate of not less than 0·9d. per car mile. The period of this contract is the same as that of the concession of the Government road. It will be noted that the conditions are most stringent, and that a net profit on the running in the city of Amsterdam could not be looked for; but, on the other hand, the distance within the city is a very short one (1·4 mile in a total run of 12), and to secure the satisfactory terminal facilities these concessions were necessary.

Messrs. Anderhagen and Neumeyer then secured an agreement with the Corporation of Haarlem permitting the construction of about 1½ miles of lines within that city, to give the Company a satisfactory terminus at its eastern end. The Haarlem concession is also for a period of fifty years, and is without unusual features, except that the concessionaires are required to pay large amounts for the renewal of bridges and similar works in the city of Haarlem.

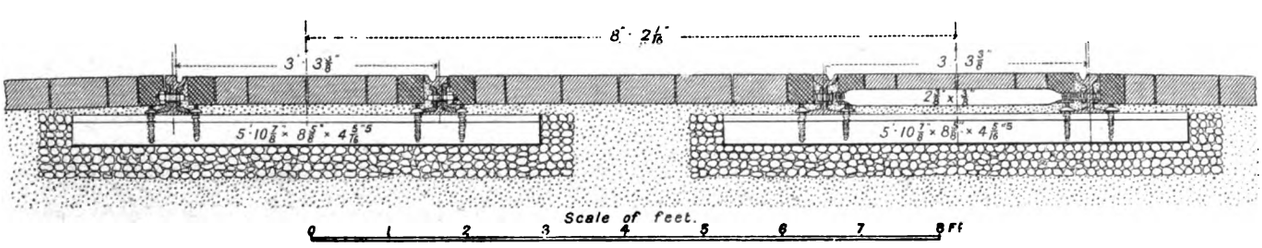
When all the concession arrangements above outlined were completed, local permits obtained, etc., the matter was presented to an American syndicate, headed by Mr. H. J. Pierce, of Buffalo, who, after full investigation, decided to take the matter up and build and operate the proposed line. The Electric Railway Company of Amsterdam—a Dutch Corporation—was organised to take over the concessions and build the line. All the shares of this Company were subscribed and fully paid for in cash by the Netherlands Tramway Company of New Jersey, the American syndicate above mentioned. The debentures of an amount equal to the amount of shares, viz.—3,000,000 guilders, were purchased outright by the well-known Amsterdam banking firm of H. Oyens and Sons.

The Netherlands Tramway Company decided that in order to secure more satisfactory terminal facilities in Haarlem and to ensure satisfactory through running arrangements between Amsterdam and Zandvoort, the seaside resort above mentioned, the local Haarlem tramway company, which had been in operation then for two years, and which is known as the First Netherlands Electric Tramways, generally abbreviated to E.N.E.T., should be purchased outright. This was carried out, and practically all the shares of the E.N.E.T. passed into the hands of the Netherlands Tramways Company of New Jersey, and for all practical purposes of operation the two lines are consolidated and to be considered as a single system.



Section of Grooved Rail and Fishplate.

Contracts were then entered into with J. G. White and Company, Limited, of London, for the complete design and construction of all the works required, including the permanent way, overhead equipment, power-station, car shed, shops, office buildings, bridges, etc., for the Amsterdam-Haarlem interurban line and for the re-construction and additions required by the E. N. E. T. This re-construction included the double tracking of the line running to Zandvoort, increase of offices and car sheds, and increase in capacity of power-station. This contract was entered into on January 1, 1903. The operation of the completed system was commenced in October, 1904. It was the intention to commence operation in the spring of 1904, but the works were delayed, due to the failure



Section of Track Construction in Streets.

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of the Corporation of Amsterdam to complete bridges, and the delay in getting approval of the Municipality of Haarlem.

THE ROUTE AND CONSTRUCTION WORK.

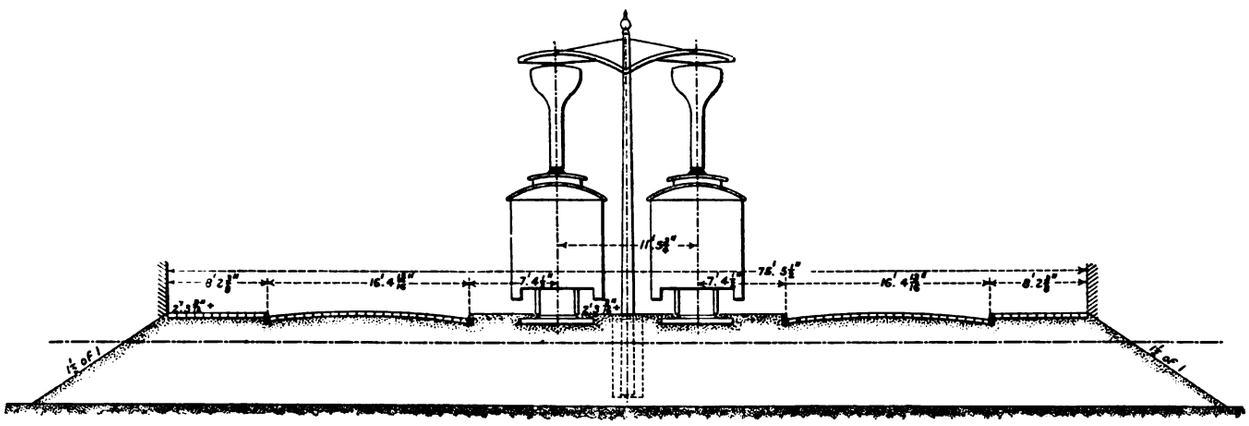
Over the greater portion of the route within the city of Amsterdam the line follows the existing tram line of the Municipality, and on such portions the third rail was laid. All the work on this section was done by the city, and the cost of it charged to the interurban line.

The bridge at the Amsterdam boundary, which is known as Kostverloren Vaart, was also constructed by the Municipality and charged to the railway company. The bridge was built and designed by the Haarlem Machine Company, and is illustrated by the photographic views herewith. It is what is generally known as the bascule type of swing bridge, and is operated electrically. This type of bridge is not easily adaptable for an overhead construction, and therefore the cars run by momentum across the bridge. There is no difficulty in this, notwithstanding the fact that there is a considerable ascending grade and a sharp curve on the Amsterdam approach. The current for working the tramcars is furnished by Amsterdam to this bridge, and also the current for working the bridge, though there is a cable connection made under the canal, so that the current furnished by the railway company to the bridge on the west side can be switched on in case of failure of the Amsterdam current.

The bridge is of 39 ft. 4 in. span, and the same width. There are 876 piles for the foundations, 230 cubic yards of other timber, 1,635 cubic yards of brickwork, 130 cubic yards of granite, and 220 tons of steel.

From the bridge the line runs over what is known as the private right-of-way for a distance of 1½ miles.

The cross section of the road over the greater portion of this part of the route is 22 ft. from building line to building line, and in the centre a strip 26 ft. wide is left for tramway tracks with centre pole construction. The average surface of the ground was 5 ft. 3 in. below the Amsterdam datum, and the height of the finished road was 2 ft. 3 in. above, making a fill of 7 ft. 6 in. The total fill was 209,000 cubic yards. The total amount of sand brought on the work to make this fill is 366,000 cubic yards. There was, therefore, used on the work 157,000 cubic yards more than shown on the embankment. This is due to the bad soil, this additional amount sinking into the ground. The sand was brought in scows for a distance of 12½ miles from



Section on Private Right of Way, with Roadway on Either Side.

View on Private Right of Way.

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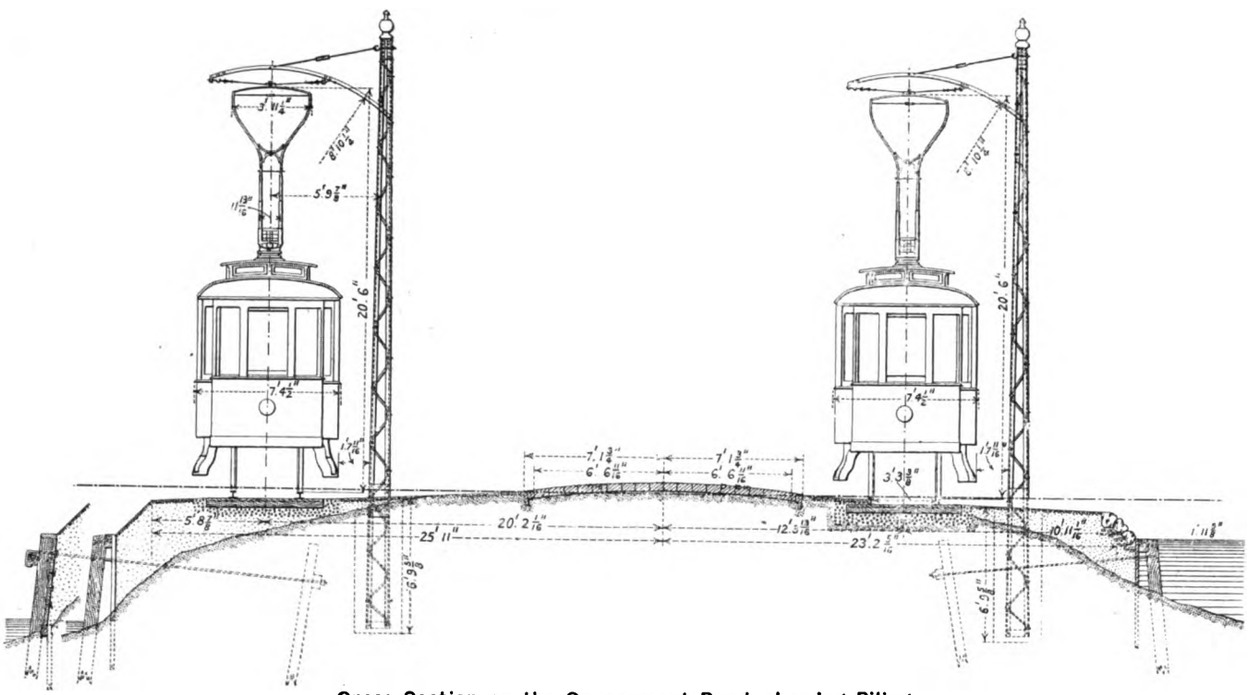
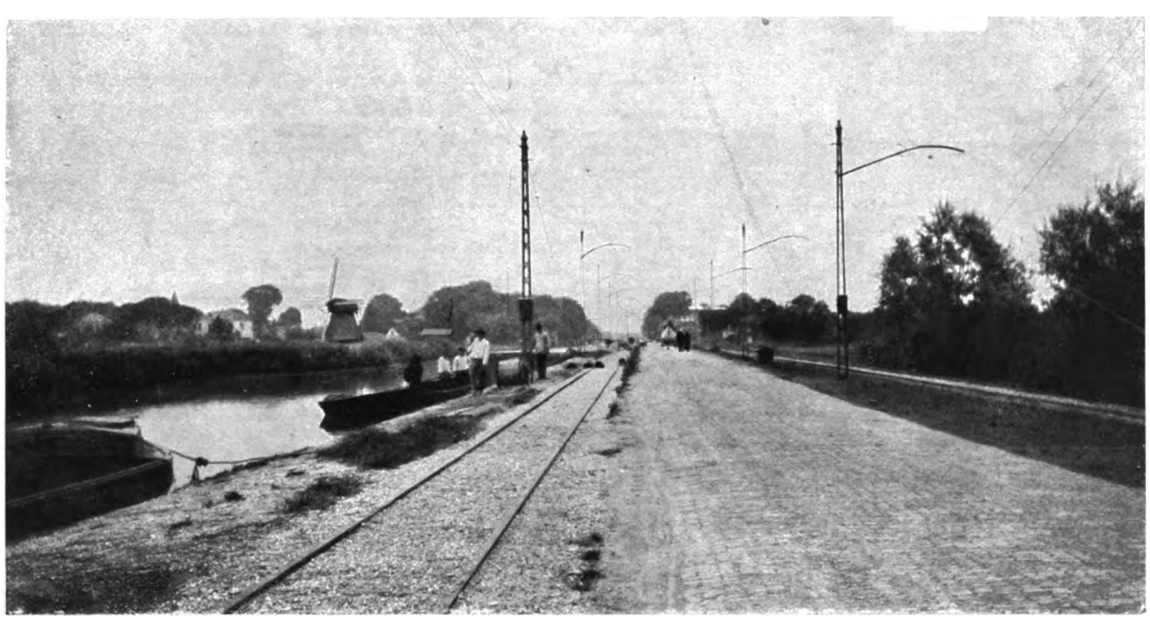
the work. It was unloaded from the canal, by means of elevators, into trucks and hauled by engines on the work. On this section two steel bridges and one wooden one had to be built.



Cross Section on the Government Road, showing Piling.

The steel bridges have a span of 16 ft. 5 in., and a width of 39 ft. 4 in. These bridges took 440 piles with 94 cubic yards of additional timber, 405 cubic yards of brickwork, 26 cubic yards of granite, and 20 tons of steel. There were also used on the private right-of-way for the approaches 500 piles, and 130 cubic yards of other timber.

At the village of Sloterdyk the line joins what is called the Government high road between Amsterdam and Haarlem. On the north side of this road is a canal running the whole length, except through the village of Halfweg. On the south side of the high road is a ditch. The ground over this distance is what is known in Holland as "polder land." The land itself is below the canal level. It is divided by ditches, generally running in a north-easterly and south-westerly direction. These ditches lead to various points, where windmills are placed to pump the water from the low level up into the canals. The land is of a boggy, peaty nature, and is used wholly for grazing purposes.



View of Railway on the Government Road.

On the *North, or Canal, Side of the Government Road* the distance from centre to centre of pile is 4 ft. The piles are of heavy kolders or hellens

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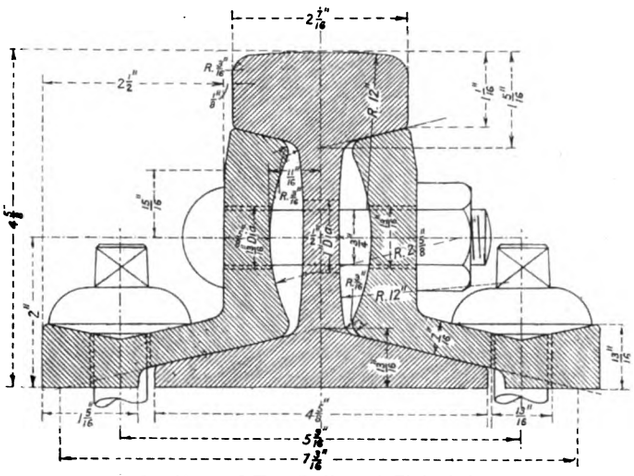
(special piles); the size is about 8½ in. at the top and 7 in. diameter at the point. The length of these piles is 16 ft. 5 in. A purlin, 5 in. by 7¾ in., of squared pine is carried along the total length of the piling, which is bolted with a ·6 of an inch bolt. These bolts are made with square heads counter-sunk into the wood. Behind this purlin a row of planks 2⅓ in. thick, 8 ft. 2 in. long, or as much longer as is shown on the cross

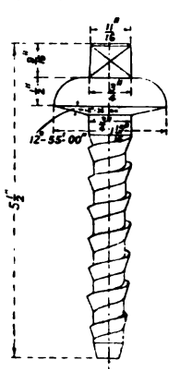


Section of Tee-Rail and Fishplate.

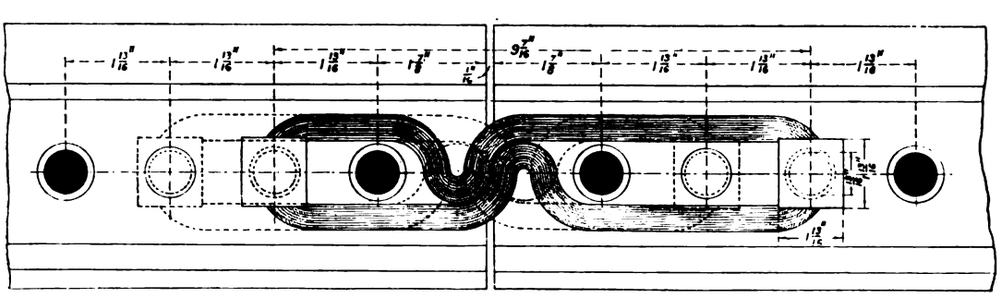
sections, is driven in; each plank is 11 9/16 in. by 11¾ in. wide. The jointing of these planks is of fish-mouth construction, and each is fixed on the purlin with three spikes. The planks are driven in perfectly vertical. At the back of every other pile two anchor piles are driven in, 9 ft. 9½ in. long, circular section, and at the head 5 in. diameter and at the point 3·9 in. diameter. Behind these anchor piles, which are 23½ in. long, 8·6 in. diameter at the head, and 7·2 in. diameter at the point; the distance between piles centre to centre is 3 ft. 7 in. The back of this piling is shuttered with boards 2 in. thick, of creosoted pine. The joints in the shuttering are covered with a strip of timber. Each plank is fixed on the pile with three spikes 5 in. long. This shuttering is made at such a depth that the bottom is 4 in. below the summer level of water in the ditch. Below this shuttering is a purlin, and behind the purlin is fixed a row of fir planks with fishmouth construction. The heads of the piles are covered with a creosoted pine plate. The purlin is fixed on each pile with a ½ in. bolt. For anchoring every alternate pile, two anchor piles 11 ft. 6 in. long, at head 5 in., and at the point 4 in. diameter, of creosoted pine are driven in. Behind these piles are anchor plates 5 in. by 5¾ in., 2 ft. 7 in. long. These anchor plates are connected with the purlin by a 1 in. round iron rod 13 ft. 1 in. long, and are provided with thread, nuts, and washers.

Behind the sheet piling, the filling has been carried out according to the cross-sections. Before commencing the sand filling, the turf was carefully taken up and stacked on the side, and the sub-soil and other material was well cleared away. The filling has been done with pure sand in level layers and well rammed down. In this filling a space is left 5¾ in. deep and 6 ft. 6 in. wide, under the bottom of the sleepers; this space is filled in up to the bottom of the sleepers with pure coarse gravelly sand.

At the south side, where the height of the slopes is more than 23½ in. above the top of the sheet piling, the slopes are built up with sods in



Screw Spike for Securing Rails to Sleepers.



Bonds at Rail Joint.

apart, there is an anchor plate made of wood, 31·2 in. long and 5 in. by 5·8 in. in section. These anchor plates are joined to the sheet piles with 1 in. round iron rods 11 ft. 7 in. long, and are provided with the necessary threads, nuts, and washers. The end of the anchor is bent round the piles and fixed with a staple. The thread for the iron anchor rods is of sufficient length to allow for the drawing up of the piling.

South Side of the Government Road.—On the south side of the Government road the piles are of roughly dressed creosoted firwood, 19 ft. 9 in.

graduated layers; the remaining slopes and the surface of the filling, so far as the sleepers, are covered either with sods or turf, 4 in. thick. Where turf is used, grass seed has been planted. The adjoining roads and approaches are filled up over their full width. The grades of the approaches are at least 1 in 40. The surface of the road and approaches is metalled in a similar manner to that employed previously.

The slopes in the canal side above the sheet piling are covered with basalt. For this purpose a layer of broken bricks 4¾ in. thick is laid on the sand filling and on this the basalt is placed,

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7¾ in. to 9¾ in. thick with a slope of 1 in 1. The pitching is well joined together and the joints filled in with small pieces of basalt, the top part being covered with sods.

The paving of the high road was practically relaid the entire length, to the stipulated datum level of Amsterdam. The amount of work involved on the Government high road may be seen from the following figures:

20,500 uncreosoted and 23,000 creosoted piles.
3,530 cubic yards uncreosoted, and 2,485 cubic yards creosoted timber.
160 tons of iron for tie-rods.
5,000 tons of basalt for projecting slopes.
98,400 cubic yards sand filling.
37,800 square yards of brick paving.
12,550 cubic yards of dredging.
1,860 yards of fencing and 74 gateways and approaches to farms and houses on the south side.

When the work was at its height on the entire line, there were employed 2,360 labourers, two steam locomotives, one electric locomotive, 31 steam pile drivers, 3 steam spouters, one steam crane, 60 hand pile drivers, one steam bucket rigger, and 165 flat boats and scows.

The permanent way along the Government high road and also along the private right-of-way is practically of steam railway construction. The rails are of the Vignole or "T" section, weighing 70 lbs. per yard. The section is the standard of the American Society of Civil Engineers for that weight. The rails rest directly

Old City Gate in Haarlem and Car Crossing New Bridge.

on the sleepers, spaced 2 ft. 5¾ in. centre to centre, except at the joints, where they are 1 ft. 7½ in. The joints are staggered. The sleepers are creosoted Norway pine, 9 in. by 4½ in., the upper edges being bevelled. The rails are fastened to the sleepers by screw bolts. Double concealed bonds are placed at each joint. The length of route along the canal is 8⅓ miles.

At the village of Halfweg, which, as the name indicates, is situated approximately half-way between Amsterdam and Haarlem, the line crosses two canals. Over these, bridges were built specially for the purposes of the tramway. One bridge has four spans, each 49 ft. 3 in., and the other two spans of the same length. There were used in the construction of these bridges, 295 piles of 49 ft. 3 in. average length, and 386 cubic yards of other timber, 366 cubic yards of brickwork, 32¾ cubic yards of granite, and 150 tons of steel.

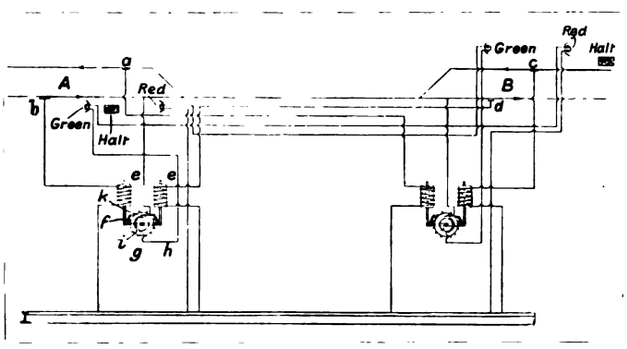

Diagram of Automatic Signalling.

Through the village of Halfweg, there are two sections of single line. These short sections are controlled by an automatic electric signalling device of the Siemens-Schuckert Company.

This apparatus operates in such a manner as to prevent two cars entering upon a section at the same time on which traffic passes in both directions, and the end points of which cannot be seen at one time. From the drawing, the arrangement of the apparatus and signals as well as the wiring diagram can be seen. It shows the wiring diagram of the apparatus and its connections with the contact pieces, a, b, c, d, and the lamp signals, overhead wiring, and connections to earth. The diagram is given only for A and B, since the connections are the same for c and d.

At each switch point where trains enter and leave, the same contact pieces, a, b, c, d, are installed, which by the passing of a car are connected by means of a stirrup with the trolley wire, and, in consequence thereof, the current flows for a brief period. This current flows through the windings of an electro-magnet (e), whereby the armature of the magnet is drawn up, and a ratchet (f) is engaged with a toothed wheel (g), and at the same time this toothed wheel turns through one section of its circumference. Firmly connected to this toothed wheel is a contact wheel (h), with one segment (i). The segment (i) forms, with the spring (k), an arrangement for breaking contact in the circuit of the light signals in such a manner that the contact is usually broken; therefore, no light burns when the section is free; that is, when no car is passing between A and B. As soon, however, as a car enters the section in one or the other direction, a turning movement acts on the toothed wheel, as above described, the lamps are lit, and when the green lamp is alight the signal is free, while when the red lamp burns, the signal is at danger. When the car leaves the single track section, and touches the contact apparatus in connection with the trolley wire, the toothed wheel is turned in the opposite direction, by means of which the spring (k) slips off from the segment and the lamps are extinguished.

It is easy to see that the apparatus works in exactly the same manner for several cars following one after the other, and that the number of cars is only limited by the number of teeth on the toothed wheel. By the entrance of each car into the section, the wheel is turned forward one tooth, and by the same car leaving the section it is turned back by one tooth, so that the lamps are extinguished only after all the cars have passed out of the section.

In case that two cars make contact at each end of the single track simultaneously, red and green lights appear on both sides. In order to prevent any confusion in the mind of the motorman, and in order to give one car the right of way, the signals have been spaced as is marked on the wiring diagram, and the stopping place is located at one end between the signals, while the stopping place is located before the signals at the other end. By this means, when by accidental simultaneous contact at both ends, the car coming from one direction will see only the green light, which means "free track." The car coming from the other direction will see from its stopping place only the red light danger signal, and will, therefore, be obliged to wait until the first car has passed the section. The apparatus and signal lights are attached to poles near the switch points. The contact pieces through which the relays are operated are spaced a short distance from the signal lights on the span wire. The signal wires, which are made of silicon bronze

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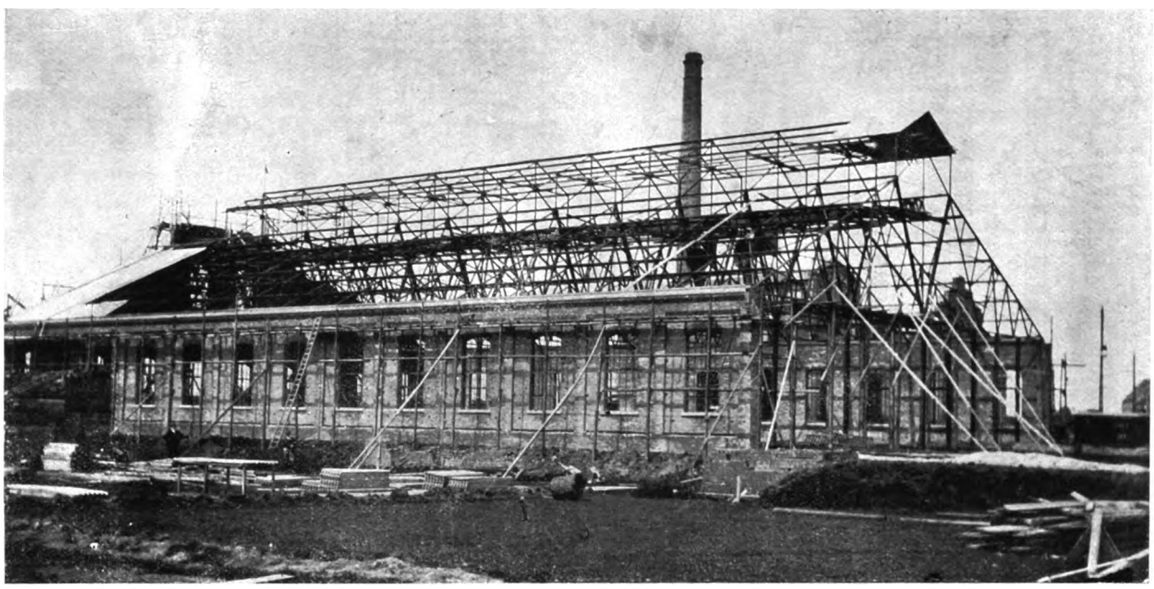
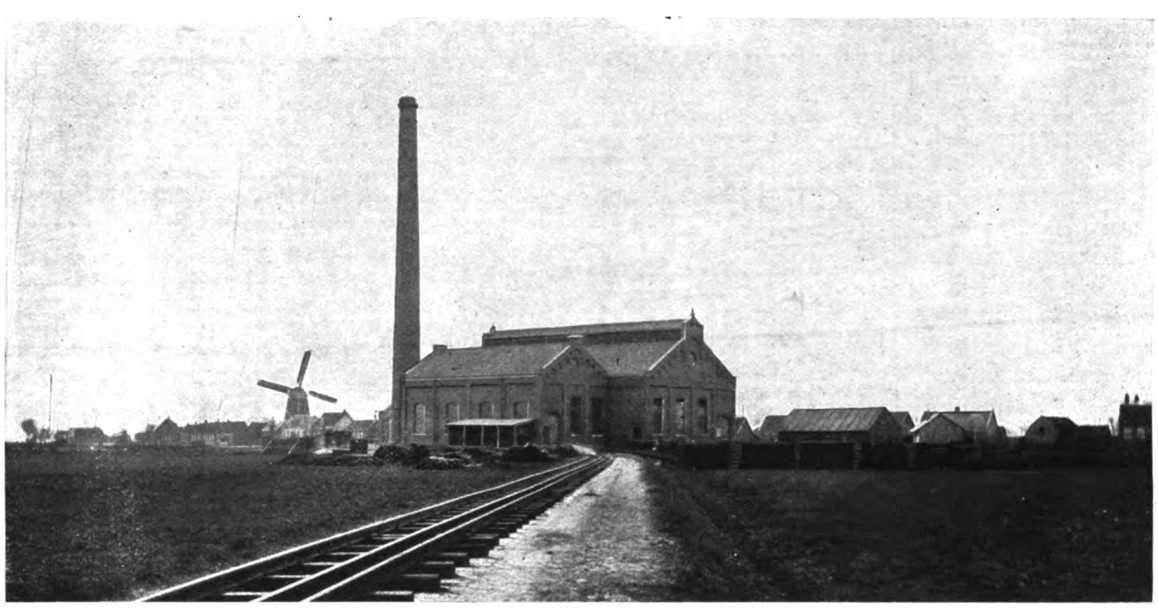
of 2 mm. diameter, are fixed to the poles by means of cross-pieces of angle iron. These cross-arms are placed between the cross-arms carrying the feeder cables and telephone wires. The insulators are made of hard porcelain. The connecting leads to the apparatus, signal lights and contacts, etc., are insulated in the best possible manner.

At what is called the Amsterdam Gate, the line enters the city of Haarlem. The terminus in Haarlem coincides with the terminus of the Zandvoort line, belonging to the E.N.E.T. system. The construction in Haarlem is all grooved girder rail. The rails weigh 84 lbs. to the yard, they rest directly on the sleepers, spaced 2 ft. 4¾ in. centre to centre, except at the joints where they are 1 ft. 9¾ in. The dimensions of the sleepers are the same as for the Vignole track. In Haarlem it was necessary to reconstruct a swing bridge, and entirely to rebuild three other bridges, and to construct a new bridge for the tram line only at the Amsterdam Gate. The new car shed was constructed alongside the existing power-station of the E.N.E.T. The pit construction in the car shed tracks was made by cast iron columns which carry the rail directly. These columns have flanged bases resting on the pile foundations. The length of the columns is 7 ft. 3 in., and the depth of the pit in the clear is 4 ft. 7 in. The distance from centre to centre of the columns is 6 ft. 7 in. The rail bridges this distance without any additional support. This construction gives the minimum of obstruction in the pits, and is simplicity itself.



Car Shed Under Construction.



Power-Station at Halfweg.

POWER STATION.

The power-house is situated in a central position at Halfweg, midway between Amsterdam and Haarlem, practically in the best position for distributing power to the line, being located on the banks of the Ringvaart Canal, which affords cheap carriage for coal and other

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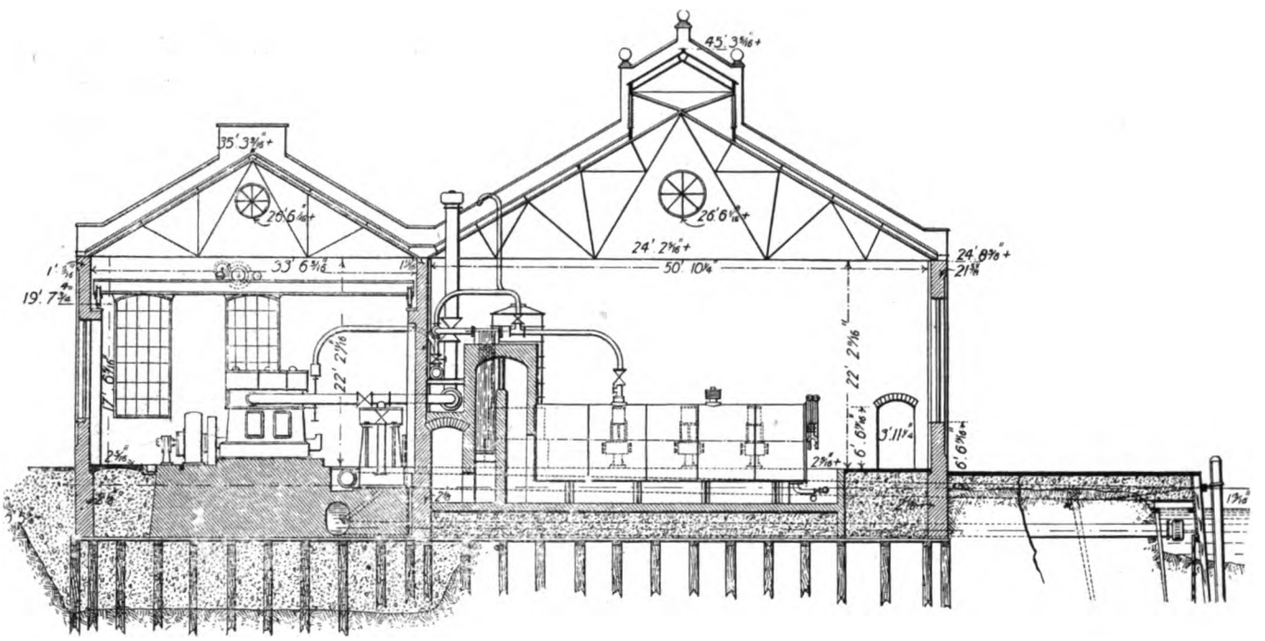
supplies, and also abundance of water for feed to boilers and jet condensation.

Owing to the nature of the country and the poor condition of ground at the site of the power-station, an elaborate arrangement of piling was necessary, the entire site being piled with 46 ft. long by $9\frac{3}{4}$ in. diameter piles, placed 4 ft. 1 in. apart, each pile being estimated to carry 4 tons. On the top of the piles, runners $7\frac{7}{8}$ in. by $9\frac{3}{4}$ in. are carried the entire length of the building, and support a floor 3 in. thick over the space occupied by the building. The piling is carried below the water level to a distance of 3 ft. $7\frac{3}{8}$ in., and from this point the foundations rise to the floor level—a height of 7 ft. $2\frac{5}{8}$ in.

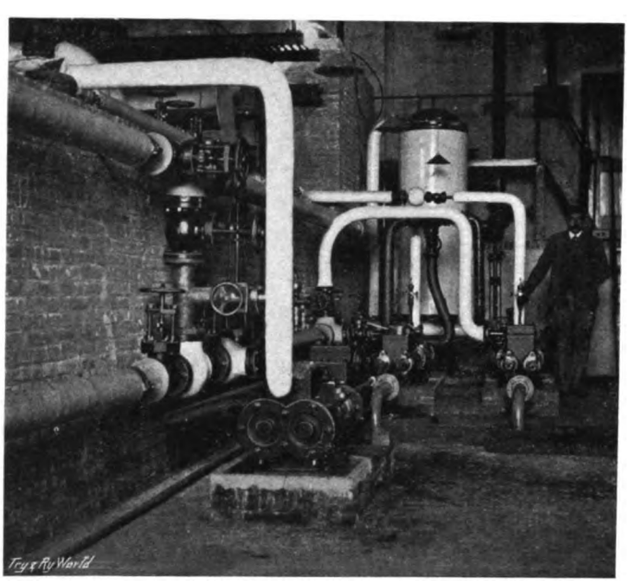
The buildings are of brick, substantially and neatly finished with stone trimmings. The ground area occupied by the power-station site is about 9,150 square feet with sufficient ground for future extensions. A wharf is erected 26 ft. 3 in. wide, and immediately adjoining is the boiler house, which is 88 ft. 7 in. by 52 ft. 6 in. A division wall separates the boiler and engine rooms. The engine room is 59 ft. by 34 ft. $7\frac{1}{2}$ in. by 21 ft. 4 in. high from engine room floor to top of wall. Situated at the end of the boiler room is a coal storage room, which is 50 ft. 8 in. by 35 ft. 4 in., with storage capacity for 400 tons. An outhouse for offices communicates with the engine room, and is 12 ft. 9 in. by 12 ft. $9\frac{1}{2}$ in.

The main engine plant consists of three Belliss patent self-lubricating, three crank, triple expansion engines, each of 430 B.H.P. at economical cut-off, and having a steam consumption of $13\frac{1}{2}$ lb. with superheated and 17 lb. with saturated steam per horse-power hour, with 26 in. vacuum. The speed is 375 revolutions per minute, and its regulation is within 3 per cent. even with sudden variations from full to no load. The engines are of the enclosed type, supported on a heavy cast iron frame, and secured by nine foundation bolts. The cylinders are 12 in., 17 in., and 26 in. by 13 in. stroke. The steam inlet is $4\frac{1}{2}$ in. in diameter, and the exhaust 11 in.

The boiler house contains six Lancashire steel boilers, by Stork, of Hengelo, Holland, the heating surface of each boiler being 926 square feet, grate area 35 square feet, and steam pressure 160 lb. per square inch. The boiler shell is 7 ft. 6 in. diameter by 27 ft. 10 in. long, and contains two furnaces each 2 ft. in diameter and each flue having 5 Galloway tubes. Other



Cross Section of Power-Station at Halfweg.



Feed Pumps at Halfweg.

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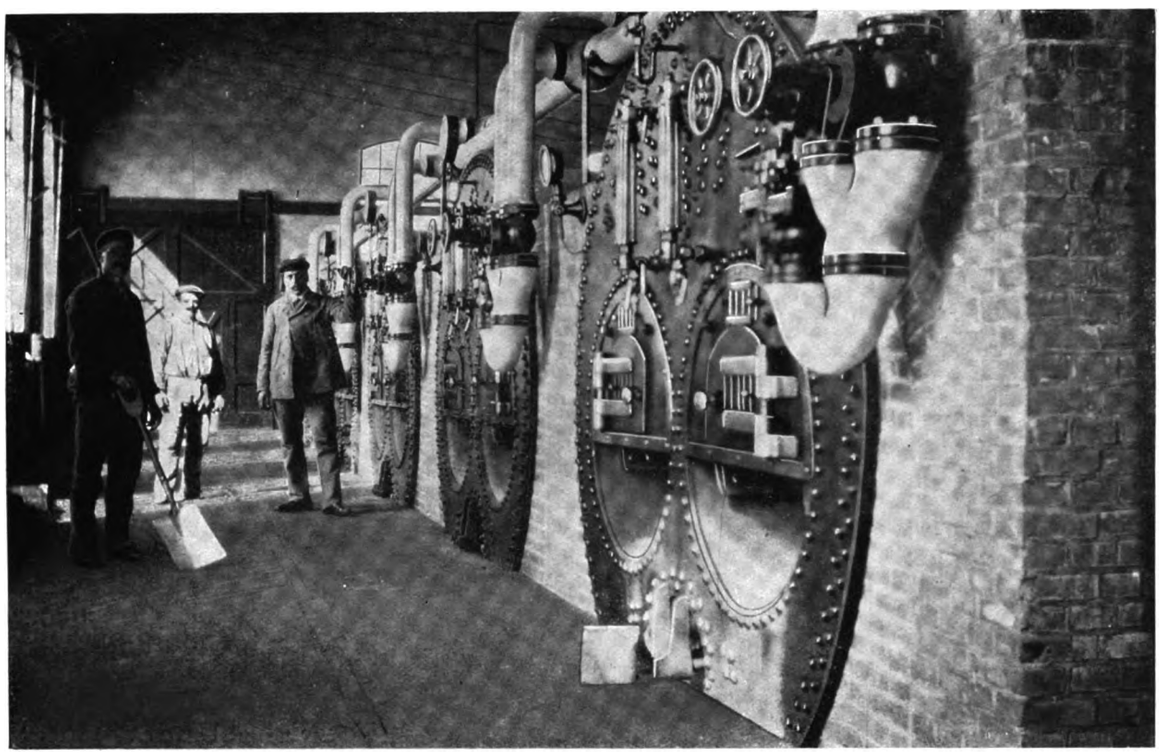
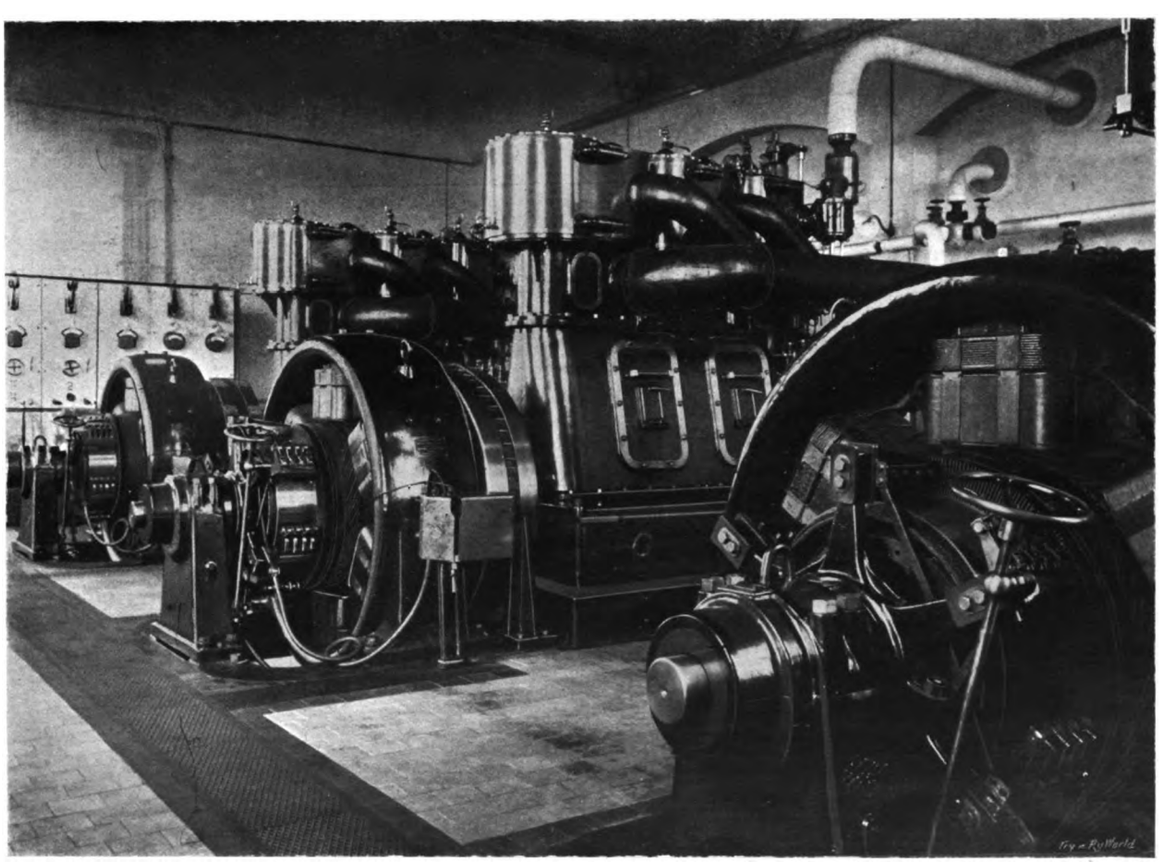


Boiler Room at Halfweg.



Interior of Engine Room at Halfweg.

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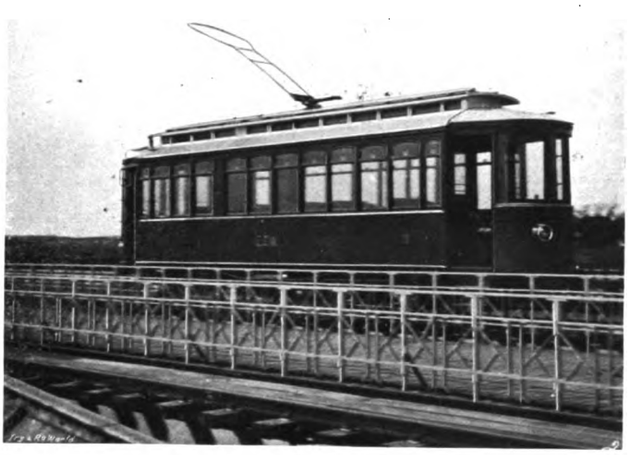
details are: safety valve 3 in., low water alarm two manholes 13 in. by 17½ in., stop valve 6 in. diameter, feed check valve 2¼ in. diameter, blow-off cock 2½ in. diameter. The boilers are stoked by hand.

There are six superheaters, also by Stork, which are placed in flues directly behind the boilers, and arranged to work at a temperature of 500 deg. F. By means of flue doors, the superheaters can be cut out and the engines worked by saturated steam. The heating surface of each superheater is 330 sq. ft.; each consists of 10 rows of coils, the ends of which terminate in two cast steel headers 8 ft. 11½ in. apart. The steam enters the one header, passes through the tubes, and discharges at the other. Fixed to the discharge steel header is a 1½ in. safety valve, a 1 in. blow-off cock, and two small holes for testing purposes.

The generators, made by the Societe Anonyme Westinghouse, Le Havre, are 3 in number coupled to the engine shafts. The output of each continuous current compound 6-pole machine is 300 KW., at 525 to 575 volts, when running at a speed of 375 r.p.m. The generator is supported on a cast iron frame, which also supports the outward bearing, the whole being secured by four foundation bolts.



Car Crossing Bridge.

The switchboard, also by the Societe Anonyme Westinghouse, consists of 5 panels (3 generating, 2 feeder), and is situated on the floor at the end of the engine room. The panels are of marble fitted to a steel frame, and having the usual standard forms of instruments, switches, etc. The cables from each of the generators are led into a trench, which runs along the ends of the generators, and terminates behind the switchboard.

The boiler foundations rise from the wooden floor, and are composed of brick arches filled in with sand. The foundations for the main engines and condensers are built of concrete, the engine centres being 14 ft. 9 in. apart. Surrounding the engine and condenser foundations are arches of concrete, which support the engine room floor.

A ten ton overhead hand travelling crane, constructed by Louis Smoulders and Company, spans the engine room, the span being 32 ft. 4 in. The motions, hoisting, and travelling, both longitudinally and transversely, are worked by means of hand chains from the engine room floor.

A round brick chimney is situated free from the building at the end of the boiler house, being 131 ft. high, by 5 ft. 5 in. diameter (internal). The chimney is lined with firebrick set in fireclay, extending from the bottom to a height of 65 ft., the foundations consisting of a large bed of concrete 23 ft. sq., by 6 ft. deep, and supported by wooden piles 9¾ in. diameter, by 46 in. long, placed 2 ft. 2 in. apart.

The condensing plant for the main engines, made by the Nederlandsche Fabrick, Amsterdam, consists of three-jet condensers, each capable of condensing 9,000 lbs. of steam per hour. The pumps are of the vertical type, the cylinders being placed side by side, supported by a cast iron frame. Directly below are the Edwards pumps, each set being secured by six foundation bolts. The condenser and injection water inlet are situated behind the pumps, the pumps discharging into a large air vessel.

The feed water to the boilers is taken from the adjoining canal, which contains an average amount of suspended matter, necessitating the filtering of the water. Under the boiler room floor, in front of the boilers, a duplicate arrangement of tanks is situated, built of brick. Each arrangement consists of a filter tank with reservoir, the filtering medium consisting of sand and clinkers, and is supported on a wooden floor perforated with holes, thus allowing the water to percolate through the medium to the reservoir. A branch pipe connecting both reservoirs leads to a hot well. Inside of the hot well and fixed to the side of the tank is a ball float valve, with connecting pipe to the water inlet supply to the condensers, the latter being used as an automatic emergency water supply in the event of the filtering tanks failing to supply the hot well. The area occupied by the filter tanks is about 710 sq. ft.

A vertical exhaust feed water tube heater, 9 ft. 7 in. high, by 24⅜ in. diameter, made by the Wheeler Condenser and Engineering Company, is placed directly behind the feed pumps, the feed water entering at the bottom and leaving at the top, the exhaust steam *vice versa*. The shell is made of cast iron, while the tubes are of seamless drawn brass. By removing the upper cover of the heater and the bottom hand hole plates, the tubes can be readily cleaned.

Two sets of direct driven horizontal duplex end-packed feed pumps, 6 in. by 3½ in., by 6 in.,

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made by the Buffalo Pump Company, New York, are installed, each capable of delivering 2,400 gallons per hour against 300 lbs. per square inch, the working steam pressure being 160 lbs. per square inch. Each unit is capable of supplying the total amount of feed water to the boilers.

Cars in Kleine Houtweg, Haarlem.

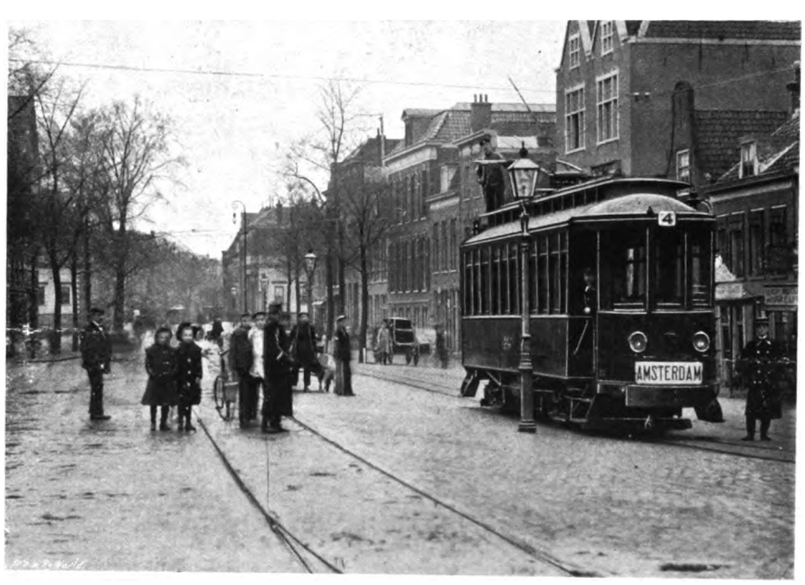
All the steam piping was made by Seiffert and Company of Berlin. From the angle stop valve on the boilers 6 in. pipes join the cast steel header of the superheater, and then branch into the main header, from which the engines take their supply of steam. The piping, which is extra heavy throughout, is arranged by closing valves in the main header, to permit the operation of this plant as three independent units. Owing to the high temperature of steam, ample allowance has been made for expansion and contraction, and the piping designed in such a way that any condensation of steam in the pipes connecting the main header, terminates in the main header, and is drawn off by three drains of large size. The following are pipe dimensions:

Main header	8 in. diamr.
Diameter of pipe from stop valve to superheater	6 in. ,,
Diameter of pipe from superheater to main heater	4½ in. ,,
Diameter of pipe from main header to engine	4½ in. ,,

The feed water piping to the boilers is arranged in duplicate. The discharge from the pumps passes through the heater into one of two mains, which runs along the side on to the top of boilers and branches off to a Y piece into the feed check valve in front of the boilers. By an arrangement of valves, the heater can be cut out and water pumped direct to the boilers. The piping is arranged so that one or more boilers can supply any one engine independently of the others, and allow the consumption of steam in the engine to be determined at any time.

From each of the three engines an exhaust pipe is carried across the engine room at a height of 6 ft. 6¾ in., and through the division wall into the boiler room, where it is supported on the main flue, the three pipes connecting up at a central position, when the pipe is increased, and an automatic relief valve is situated in the vertical pipe leading to the atmosphere, on which there is an exhaust header. A branch pipe is taken from each exhaust pipe from the engine into an independent jet condenser, by valves situated conveniently in the piping. The arrangement will permit the operation of any engine working in conjuction with any condenser. The exhaust pipes are 11 in. and 16 in. in diameter.

The auxiliary units (feed pumps and jet condensers) are worked with saturated steam taken from branches off the main steam pipe, between stop valves and superheaters, and this piping is designed on the loop system, alternate boilers connecting one side of the loop. From the loop a main is taken, in which a separator is fixed, before entering the engine room, where it branches off to the three condensers. Other branches are taken to supply the feed pumps.



Car in Houtplein, Haarlem.

ROLLING STOCK.

The 34 cars were made by La Metallurgique at Nivelles, Belgium. They are divided into

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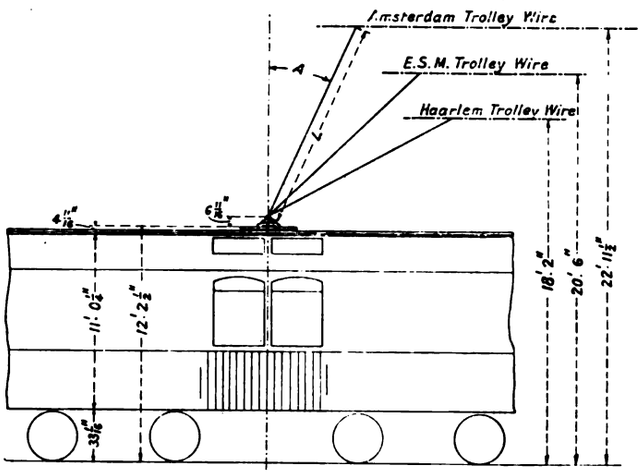
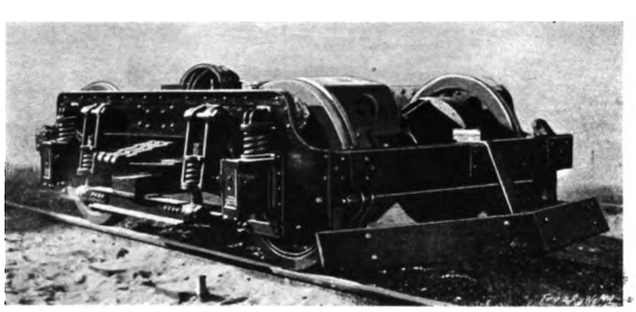
two compartments, the larger for seating 22 passengers, and the other 12. The smaller compartment is for smoking. The cars are vestibuled. Besides the hand brakes, the cars



Heights of Trolley Wires on the Three Systems.

are equipped with Christensen air brake, supplied by R. W. Blackwell and Company, Limited, London. Air pumps are worked by an electric motor automatically regulated. The trucks were also furnished by La Metallurgique. The special feature of these trucks is that the swing hangers are pivoted on the outside of the truck frame. This permits a maximum distance between the supports of the spring plank and a

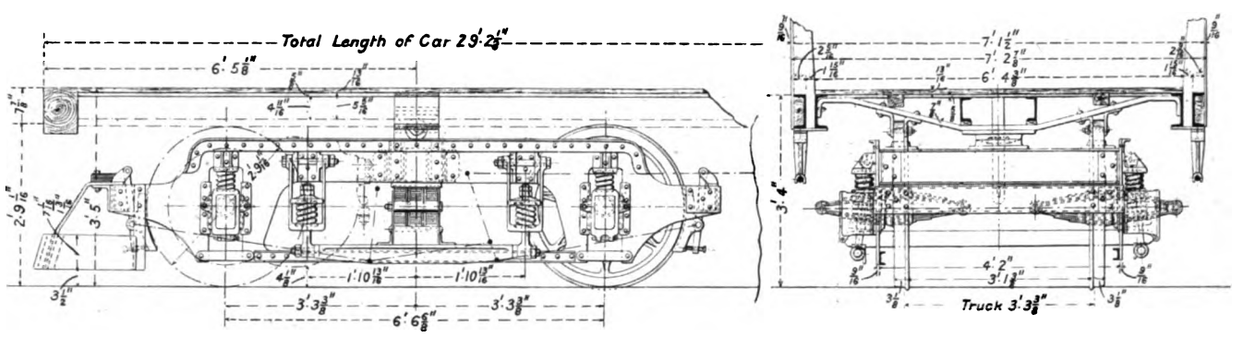


View of Car Truck.

maximum distance centre to centre of the swing hangers. The result of this construction has been most satisfactory. The trucks are very easy riding, even at the higher speeds of 35 to 40 miles per hour.

The motors are of 50 H.P., furnished by the Union Elektricitäts Gesellschaft, now incorporated with the Allgemeine Elektricitäts Gesellschaft.

The overhead equipment is on the bow system, with a pressure of 500 to 575 volts. The poles are of the lattice girder type, of three different weights, viz., 550 lb., 697 lb., and 1,298 lb. The first two are constructed of two channel sections bolted together, and the third with angles. The poles are provided with heel plates, and set 6 ft. 6½ in. in concrete. The bracket arms consist of two channel sections bolted together. Bracket arm construction is used throughout except in Haarlem, and the poles carry both the feeder cables and telephone wires. The feeder cables consist of two bare copper conductors, each ·3 sq. in. section. The trolley wire is ·105 sq. in. in section. On that part of the route from Haarlem to Zandvoort, bow contact is made with two wires simultaneously. The trolley wire is zig-zagged, in order to equalise the wear on the bow. The height of the wire from the ground varies in Amsterdam, on the Government road, and on the E.N.E.T. section; this variation in height caused at first considerable trouble with the bows, but at present the bow base is so arranged as to keep an equal tension on the bow at the respective heights. The wire is screwed and held up by mechanical clips, which, with the bow, gives noiseless running. The whole overhead construction impresses one with a sense of lightness, without loss of strength.



Side and End Elevations of Motor Trucks.

LIGHT RAILWAY COMMISSION.—The Light Railway Commissioners have issued their draft North Lindsey Light Railways (Amendment) Order, 1904, amending the North Lindsey Light Railways Order, 1900. The Commissioners on December 28 submitted to the Board of Trade for confirmation the Campbeltown and Machrihanish Light Railway Order, authorising the construction of a light railway in the county of Argyll from Campbeltown to Machrihanish.

THE KINGSLAND MECHANICAL SURFACE-CONTACT SYSTEM.—The Traction Company of the United Kingdom, Limited, have offered to instal in Birmingham four or five miles of track on the Kingsland system (at a price to be mutually agreed beforehand, to work it for a definite period, and if it fails to meet the tests and conditions to be mutually agreed upon, to substitute the overhead equipment free of cost. No installation of the system is at present working in this country, but on one of the main thoroughfares in Dresden the Traction Company have equipped a length of the existing tramways with this method to demonstrate its working, and to show the ease with which it is possible to work from one system to the other. The municipality of Dresden has approved this installation, subject to the addition of a double-slot crossing, and this is at present being fitted.

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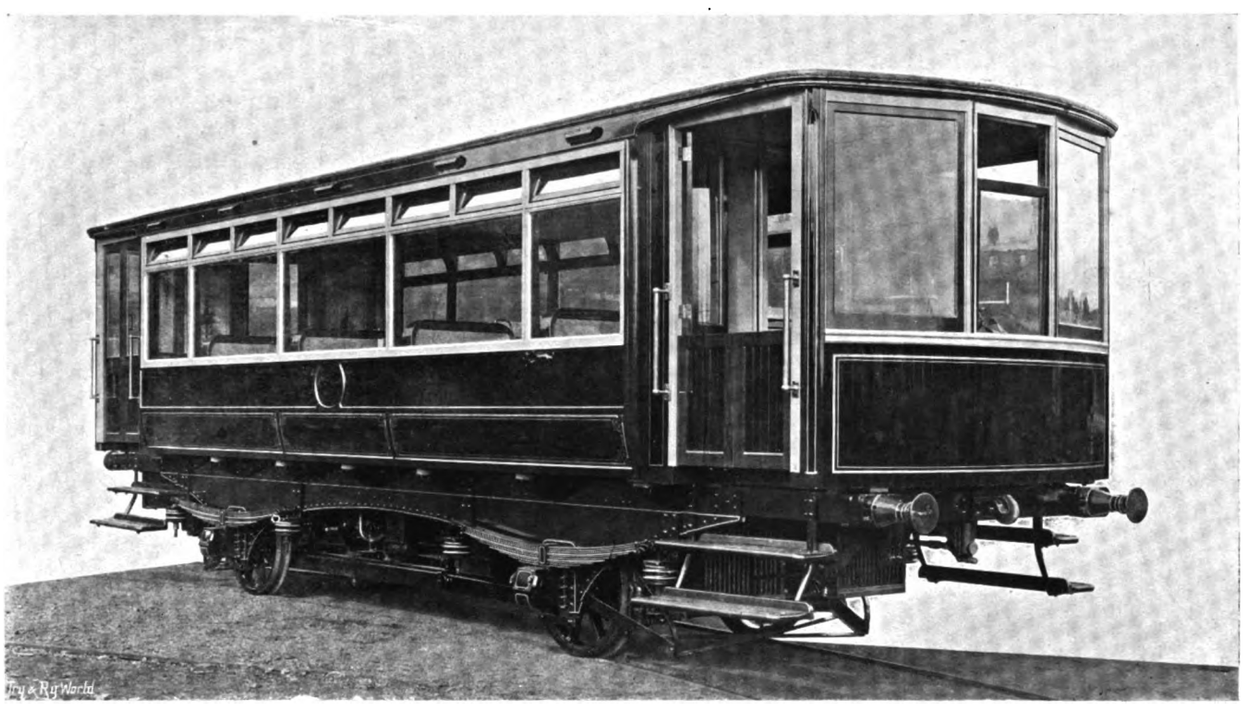
A PETROL MOTOR CAR FOR RAILWAYS.

The economical operation of short branch lines traversing sparsely populated country, has long been one of the most important problems of railway management, and it is generally admitted that expense of working arises from the necessity of employing steam locomotives. The ordinary steam-hauled train works to the best advantage either over long distances or where traffic is fairly dense, but is unsatisfactory where traffic is light, for the reason that it is impossible materially to reduce the number of operators. Even under conditions which would permit the use of short trains, it has been incumbent to employ two men on the locomotive and at least one guard on the train. In addition to the use of a considerable amount of rolling stock for unremunerative traffic, there are the stand-by losses which must be a very serious matter in the case of a railway system on which branch lines were numerous.

It is evident, that under such conditions an automobile type of car presents obvious advantages, and recognising the possibilities of such a type of vehicle, railway managers have evinced the keenest interest in the development of a self-contained coach for railways, and the great improvements that have arisen during the last few years in road cars would justify the conclusion that such a type of vehicle might be adopted with success on a railway service.

For some time past a good deal of experimental work has been carried on by various railways throughout the country to determine which type of automobile seemed best suited to their peculiar conditions. While some railways have been carrying out experiments with steam automobiles, others have adopted petrol cars, and in one case a combined petrol and electric car has been employed. But though an automobile system immediately reduces the operating staff, gives a greater degree of flexibility, and obviates the necessity of much rolling stock lying idle, there are at the same time certain conditions which the automobile must meet, even presuming a reliable type of motor is obtained, in order to ensure its successful application. It is essential that such a vehicle should deal with traffic under periods of abnormal demand, yet be capable of economical operation if traffic is light. Moreover, under some conditions it would not be sufficient that an automobile should be powerful enough to draw its own load, because there are cases where it would be an advantage for such a vehicle to be able to draw an extra coach, a goods van, or horse box.



Dick-Kerr Petrol Motor Car on the G.N.R.

During the past few months the Great Northern Railway Company have been carrying out most interesting experiments in this direction. Probably no railway in the country has a larger number of branch lines traversing thinly populated districts than this Company, and, as on other railways, many of these branch lines were unremunerative. Yet, as feeders to the main line system, the short branch lines are exceedingly necessary, and under these conditions an automobile—if a satisfactory one could be devised—appeared to offer considerable advantages. With this clearly before them, the Great Northern Railway Company have been operating a petrol car, which, while being

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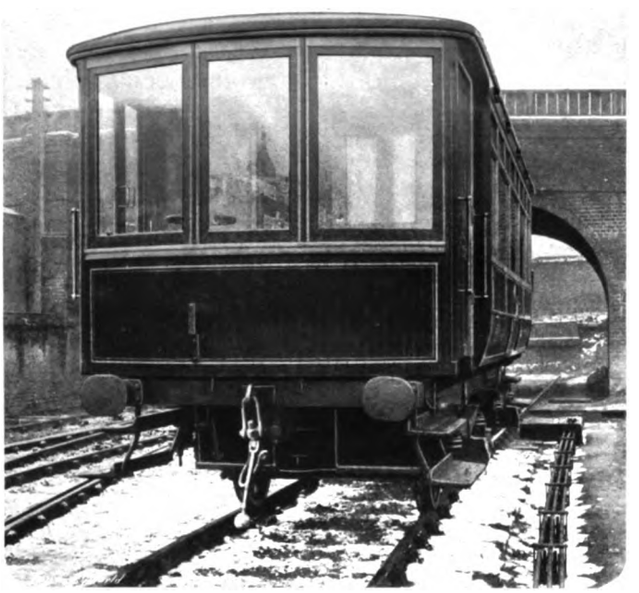
valuable in demonstrating the possibilities of this class of vehicle under special conditions, is also interesting on account of new features which in many respects constitute a distinct advance in this type of vehicle. The car has been specially designed by Messrs. Dick, Kerr and Company, and in evolving it they have been able to utilise their special experience in electric tramcar construction. The system of applying two electric motors to a tramcar has been copied in the automobile, two petrol engines being employed, which are connected to a shaft in a manner which will be described.

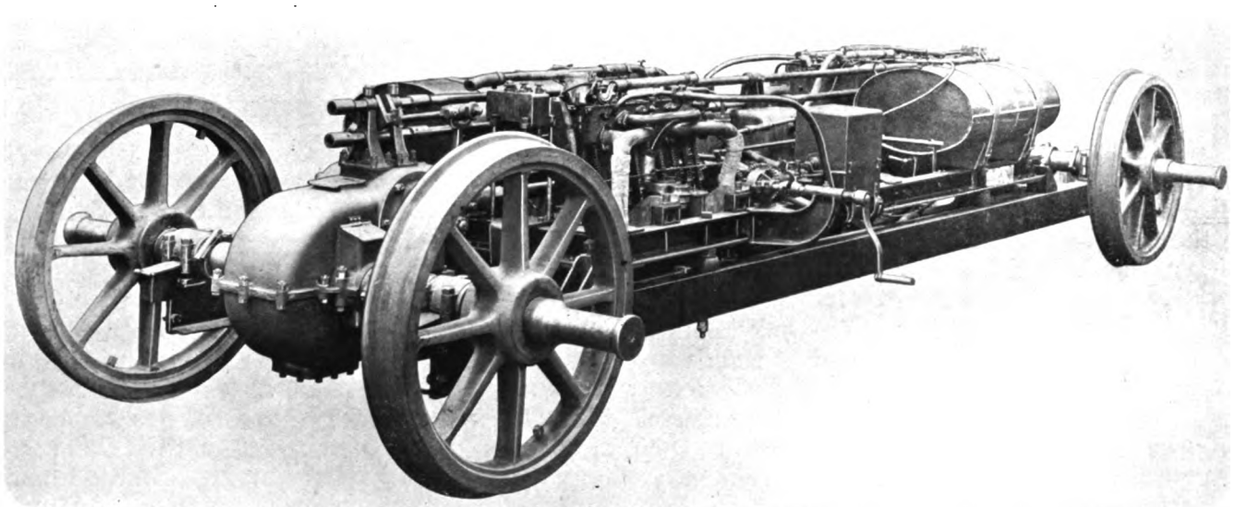
The car which is now being worked on the Great Northern Railway will be, in all probability, utilised on one of the branch lines running from Hatfield. The seating capacity is 32 passengers, but it is obvious that this can be considerably increased, and the firm is already engaged on a larger type of car, which will not only carry considerably more passengers, but will also provide a certain amount of space for luggage.



End View.

vibration from the engines is quite imperceptible to the passengers.

As already indicated, following the practice now generally employed in electrically driven cars, the motive power consists of two engines which not only minimises the risk of breakdown but gives a better distribution of weight. The engines are not, however, connected independently to the axles, although both axles are driven, but under normal circumstances drive on to a common longitudinal shaft, which is connected to the axles by bevelled gearing. To overcome the difficulty of one axle over-running the other, owing to any possible inequality in the diameter of the wheels, a special form of differential gear is introduced, and combined with this special gear is the reversing mechanism. The engines are connected through independent clutches to a common change speed box from which the power is transmitted, by means of the longitudinal driving shaft, into gear boxes suspended on each axle, and at this point the engine speed is



Frame of the Dick-Kerr Car with Daimler Engine.

The whole of the machinery is assembled upon a frame, which is directly supported from the axles. It is thus entirely insulated from the body of the coach, with the consequence that even while standing at a station the noise and

reduced as required on the axles by means of single reduction gearing very similar to that used in electric tramway motors. The engines are of the standard Daimler type, each capable of developing 36 H.P., running at full speed. A

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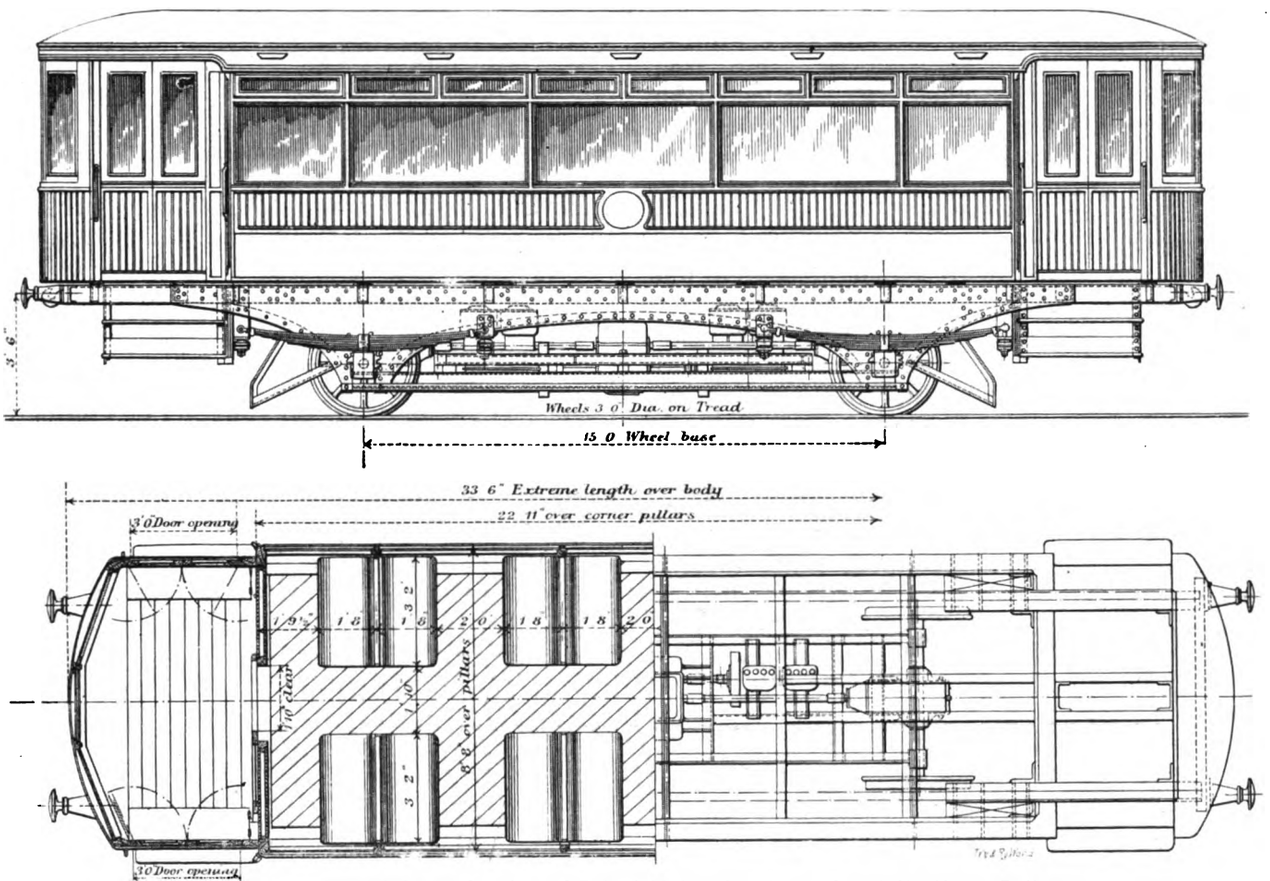
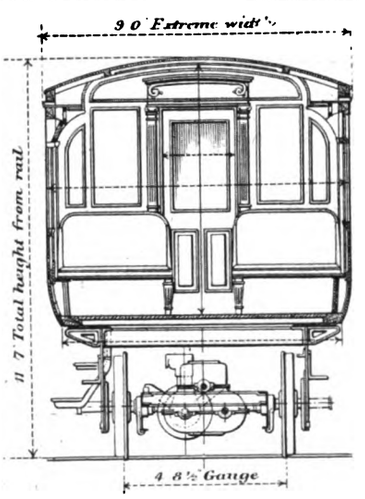
separate petrol tank is provided for each engine, and the combined capacity of these is equal to 400 car miles.

The complete car weighs something under 16 tons, including its full complement of passengers, and although the normal speed for which it is designed is 30 miles per hour, it has on several occasions attained a speed considerably over 50 miles. The car is lighted by electricity obtained from storage batteries, which also supply current for the ignition and magnetic clutches. The design of the complete car is such that by jacking up the body the underframe and machinery can be run out in the same manner that a truck can be taken from beneath an electric tramway car, but, in addition to this, the frame containing the machinery can be dropped from its bearings on the axles without removing the truck from underneath the car body, so that it will be seen that the flexibility and facilities for overhauling and repairs are everything that can be desired. The engines are made by the Daimler Motor Company, of Coventry, who have also manufactured the greater portion of the transmission gear. The patents covering the arrangement, however, are entirely controlled by Messrs. Dick, Kerr, and Company. The design of the car and its experimental operation have been under the personal supervision of Mr. Oliver Bury, the general manager of the Great Northern Railway Company.



Elevation, Plan, and Cross Section of Petrol Motor Carriage—Great Northern Railway.

KILMARNOCK CORPORATION TRAMWAYS.



Kilmarnock Corporation Tramways were opened on December 10 by Lord Howard de Walden. The route consists of half a mile of double line and three and three-quarter miles of single line. The car sheds are capable of accommodating 12 cars, and there is ample room for extension. Eleven cars are now ready. They were supplied by Messrs. Hurst, Nelson and Company, Motherwell, are seated for 52 passengers, and have the ordinary type of staircase, with an extended canopy top. They are painted olive green and cream, and bear the burgh coat-of-arms on each side. The track was constructed by Messrs. Dick, Kerr and Company, and the overhead equipment by Messrs. R. W. Blackwell and Company, while the whole of the cables were laid by the Callender Cable and Construction Company. The total cost of the lighting part of the scheme, which was put in operation in November, is expected to reach £37,000, and the cost of the tramways will be about £42,000. The engineers were Messrs. Kennedy and Jenkin, London.

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METROPOLITAN RAILWAY ELECTRIFICATION.

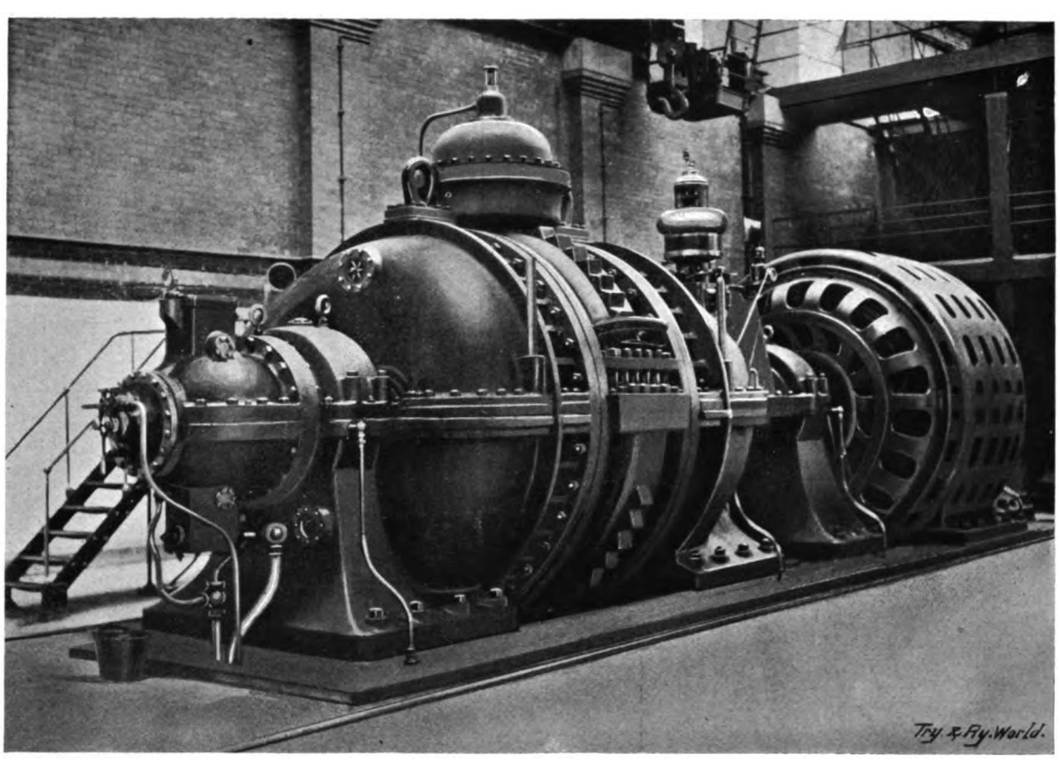
First Electric Train to Uxbridge.

On December 13 the Metropolitan Railway Company ran their first electric train from Baker Street to Uxbridge. This special train carried a party of about 150 invited guests, and the journey to Uxbridge, a distance of about 16 miles, was accomplished without a stop or a hitch, in a little over half-an-hour. After a short stay at the rural terminus, the return journey was made with equal despatch and smoothness. The train consisted of six cars of the new electric rolling stock, and these were conspicuous by their fine appearance, both externally and internally, their brilliant lighting, and the smoothness of their running.

Prior to the journey the party were entertained at lunch in the Hotel Great Central, Marylebone. Sir Charles McLaren, Bart., M.P., chairman of the Metropolitan Railway Company, presided, and among those present were:

Colonel J. J. Mellor, Lieut.-Colonel Clifford Probyn, Mr. J. Light, and Sir Wm. Birt, directors of the Metropolitan Railway; Colonel Wm. Terry, director of the Harrow and Uxbridge Railway Company; Messrs. S. Fay, O. S. Holt, D. Davies, C. A. Rowlandson, R. Haig-Brown, and J. G. Robinson, of the Great Central Railway; Messrs. J. F. S. Gooday, R. P. Ellis, and W. H. Hyde, of the Great Eastern Railway; Mr. W. J. Grinling, of the Great Northern Railway; Messrs. J. A. F. Aspinall, C. J. Nicholson, and O. Winder, of the Lancashire and Yorkshire Railway; Messrs. W. Forbes, C. L. Morgan, and G. Allen, of the London, Brighton and South Coast Railway; Sir F. Harrison, of the London and North Western Railway; Sir C. Owens, of the London and South Western Railway: Mr. A. L. Stride, of the London, Tilbury and Southend Railway; Mr. Wilson Worsdell, of the North Eastern Railway; Mr. J. F. Dunn, of the North London Railway; Mr. J. R. Chapman, of the Underground Electric Railways Company of London; Mr. H. Smart, of the Railway Clearing House; Sir J. Wolfe Barry, Sir Ralph K. Littler, Sir F. Dixon-Hartland, Professor Silvanus Thompson, Mr. D. McMillan, etc.

Sir Charles McLaren, addressing the gathering at the close of the luncheon, said that that was the opening day for electric traction on the Metropolitan Railway, though, perhaps, not an opening day such as the public expected, because the Company could not by a stroke of the wand change from steam to electric working. That change could only be brought about gradually by interpolating electric trains among the steam trains. On January 1 they hoped to have a complete system of electric trains running between Baker Street and Uxbridge. They were, to some extent, in the hands of the District Railway Company as far as the Inner Circle traffic was concerned, but he had no reason to doubt that when they were ready with the full equipment of the Metropolitan Railway the



5,000 H.P. Turbo-Generator.

Messrs. A. C. Ellis, R. H. Selbie, C. de Winton Kitcat, E. P. Seaton, A. B. Garside, T. Parker, H. B. Palmer, C. Jones, A. Ingram, T. F. Clark, W. H. Brown, J. H. Finlayson, E. R. Vaughan, E. G. Phillips, W. Marsh, M. Garbutt, and L. B. Warmington, officers of the Metropolitan Railway; Major L. H. Isaacs, Messrs. J. Young, E. Soar, and G. Estall, of the Metropolitan District Railway; Messrs. G. J. Churchward and W. Y. Armstrong, of the Great Western Railway; Dr. A. B. W. Kennedy, of Messrs. Kennedy & Jenkin; Messrs. V. W. Hill and C. Sheath, of the South Eastern and Chatham Railway; Messrs. G. C. Cunningham and R. O. Graham, of the Central London Railway; Mr. T. C. Jenkin, of the City and South London Railway;

District Railway would be ready to undertake their share of the work. They had a complete understanding with the District Company for interchange of current at any points where that might be necessary. He had no cause to doubt, from the experiments they had already made on the Uxbridge line, that they would have very successful running on the underground portion

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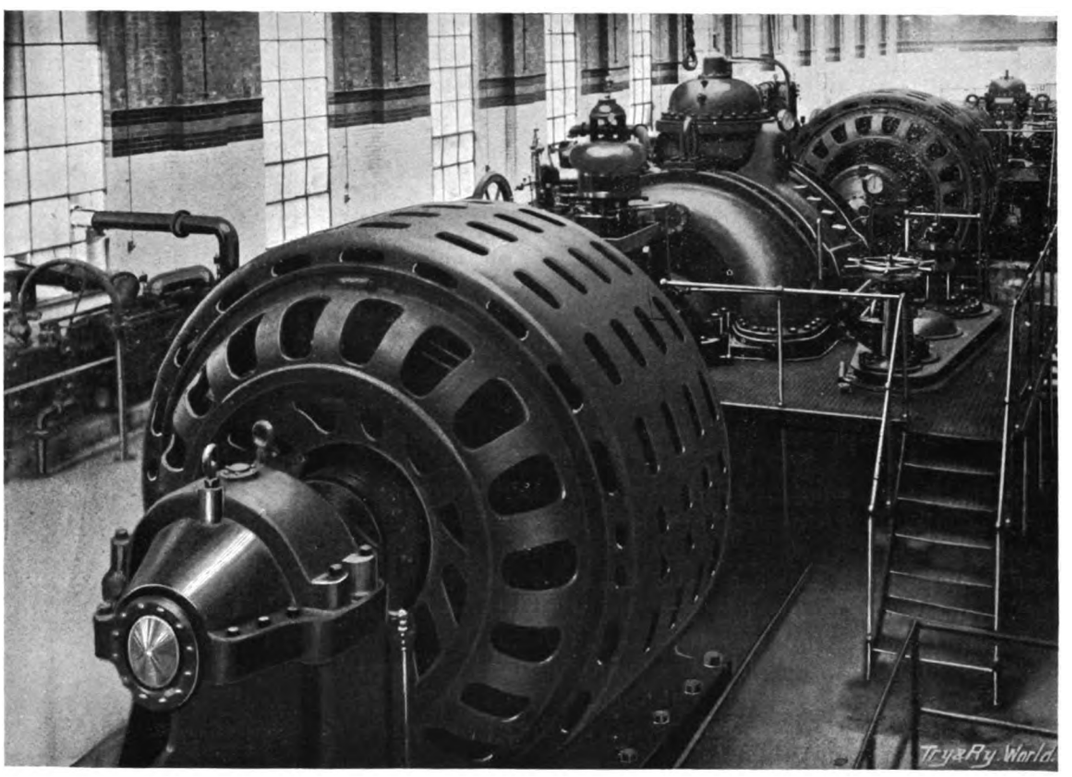
of their line. Their cars, which had all been built in England of British material, were constructed largely of steel and aluminium, and all inflammable material had, as far as possible, been eliminated, so that in the event of a short-circuit there would be no danger of conflagration. The station platforms were being changed so that they would consist of nothing but concrete and stone. The company had the largest tunnels in the London area, as they were constructed for the running of Great Western broad-gauge trains, and safety and good ventilation were thus secured. He was perfectly certain that when the tunnels had been cleaned the railway in them would be second to none. The directors hoped that increased facilities would bring them increased traffic. The possibilities of London traffic were simply enormous, but if they wanted to get the traffic they must give the most up-to-date facilities. The question for shareholders was whether the expenditure would be profitable. The directors had been forced by public opinion to take this great step, and they had been forced, to some extent, by the Board of Trade also. It had been a very costly step, but they hoped that the increased numbers of the public who would travel by their line would recoup them, and also increase the earnings on the company's original stock.

In our issue of July 14, last year, there was published a very full illustrated description of the work of electrifying the Metropolitan Railway. On the present occasion, however, it is well to give a resumè and to bring matters down to date. The lines which have been electrified, some 26 miles in length, embrace the Metropolitan Company's portion of the Inner Circle, their main line to the country as far as Harrow, and the branch from that town to Uxbridge. The remainder of the company's system, running northwards through Buckinghamshire to Verney Junction, remains under steam traction. The electrical equipment of the permanent way was carried out by the railway company's own staff, and this was done under circumstances of some difficulty owing to the frequent service of trains on the railway. Over most of the route new track rails were laid of the standard bull-head type, weighing 86 lb. per yard. The branch from Harrow to Uxbridge is a new railway, and was constructed as an electric line with rails coming from the North Eastern Steel Company. Two conductor rails have been laid throughout. These are of Vignoles section, weigh 100 lb. per yard, and were also supplied by the North Eastern Steel Company. The positive conductor is placed 16 in. outside the outer track rail, while the negative conductor is situated centrally between the track rails. These conductor rails are of basic steel, containing less than ·05 per cent. of carbon, and the electrical resistance is only six and a half times that of pure copper. Double bonds under the base of the rail, supplied by the Forest City Electric Company, are used, and the rails are supported on insulators from the firm of Bullers.



Two of the Generating Sets.

The power-station is at Neasden, beside the works of the railway company. The main building is 327 ft. long by 101 ft. wide, and covers 3,570 sq. yds. Steam is raised by Babcock and

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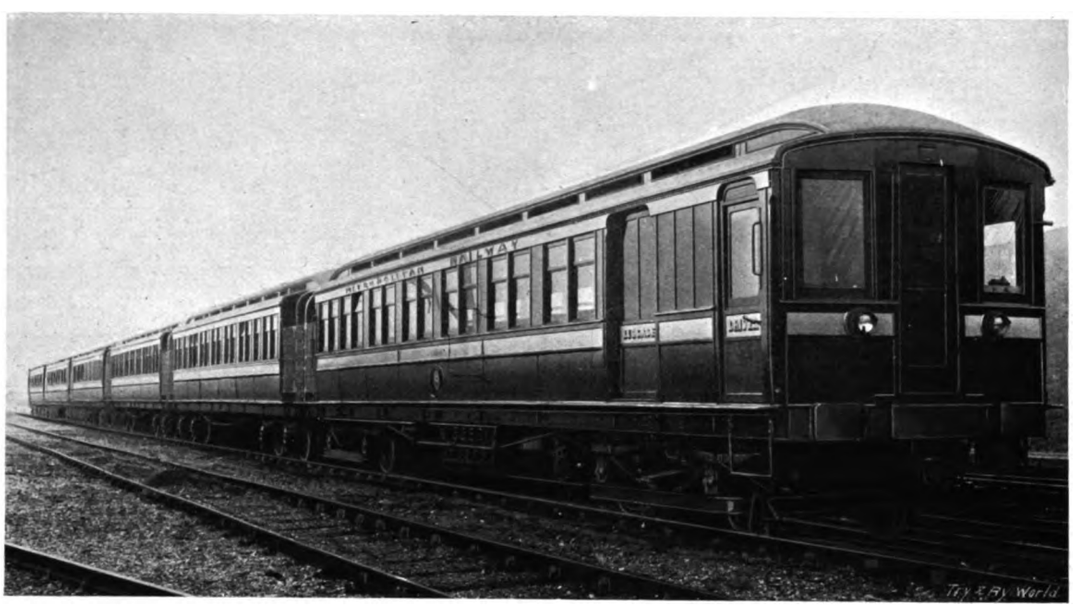
Wilcox boilers, each of 5,730 sq. ft. heating surface, and fitted with mechanical stokers and superheaters. Each boiler can evaporate 20,000 lb. of water per hour to a pressure of 180 lb. per sq. in., and the superheat is to a total temperature of 520 deg. F. The coal is carried to storage bunkers above the boilers by a bucket conveyor of Graham, Morton, and Company's make, and is fed down to the stokers by shoots. The conveyor also removes the ashes at the bottom. Green's economisers, with 1,760 tubes, are employed. The chimney is 200 ft. high and 15 ft. in diameter.

In the engine room, 234 ft. by 43 ft., are four Westinghouse steam turbines of 5,000 brake horse-power each, driving three-phase generators. The turbines are of the double-flow multiple-expansion type, and run at 1,000 revolutions per minute. The dynamos generate current at a pressure of 11,000 volts, 33⅓ cycles per second, and are rated at 3,500 KW. each. They are of the revolving field type, and there are four field poles. The efficiency at full load is 96½ per cent. The exhaust steam passes to Alberger condensers, and the circulating water is cooled in towers of Donat and Company's type. The two exciters for the main generators are of the Westinghouse make, and each consists of a compound engine coupled to a 100 KW. direct-current generator. The various pumps are of the Gwynne, Worthington, Alberger, and Weir types.

Regarding the Westinghouse switchboards, there are two sets of main bus-bars. Each generator can feed into either set through two switches in series. The whole apparatus is mounted on masonry built in the galleries. All the main switches are worked from a control board.

Three-core 11,000-volt armoured cables, supplied by the British Insulated and Helsby Cables, Limited, lead the current to nine sub-stations. There are in all about 75 miles of these cables; they are laid on the solid system from Uxbridge to Finchley Road, and on brackets in the tunnels from Finchley Road to Baker Street and on the Metropolitan Railway Company's portion of the Inner Circle. In the sub-stations Westinghouse transformers and converters change the current to 550-volt continuous for sending out to the conductor rails. The latter work is done by low-tension, rubber-insulated, lead-covered cables which have also been supplied and installed by the British Insulated and Helsby Company.

The rolling stock is of a very fine pattern, and comes from the shops of the Metropolitan Amalgamated Railway Carriage and Wagon Company. First and second class cars have been provided; all are 52½ ft. long, and the two classes differ only in the pattern of seat upholstery and in some of the internal decorations. In both cases, however, the arrangements are very elegant and comfortable. Cross as well as longitudinal seats are provided, and the gangway is central. At the ends are sliding doors, and the platforms are closed by swing gates. The cars are brilliantly lighted, and the electric lamp fittings are most artistic. In the construction of the bodies, every provision has been made to insure the fullest protection against fire. Each motor car seats 49, and each trailer car 56 passengers. The bogie trucks are by the Leeds Forge Company, and the wheels are steel-tyred 36 in. in diameter. The Westinghouse air brake is fitted throughout. Each train is composed of six cars, two of which—one at either end—are motor cars. Each motor car has four Westinghouse 150 H.P. motors, giving 1,200 H.P. per train. The motor control equipment is of the Westinghouse turret multiple-unit type.



Metropolitan Railway Electric Train.

The installation of the whole system has been carried out under the direction of Mr. A. C. Ellis, general manager of the Metropolitan Railway Company.

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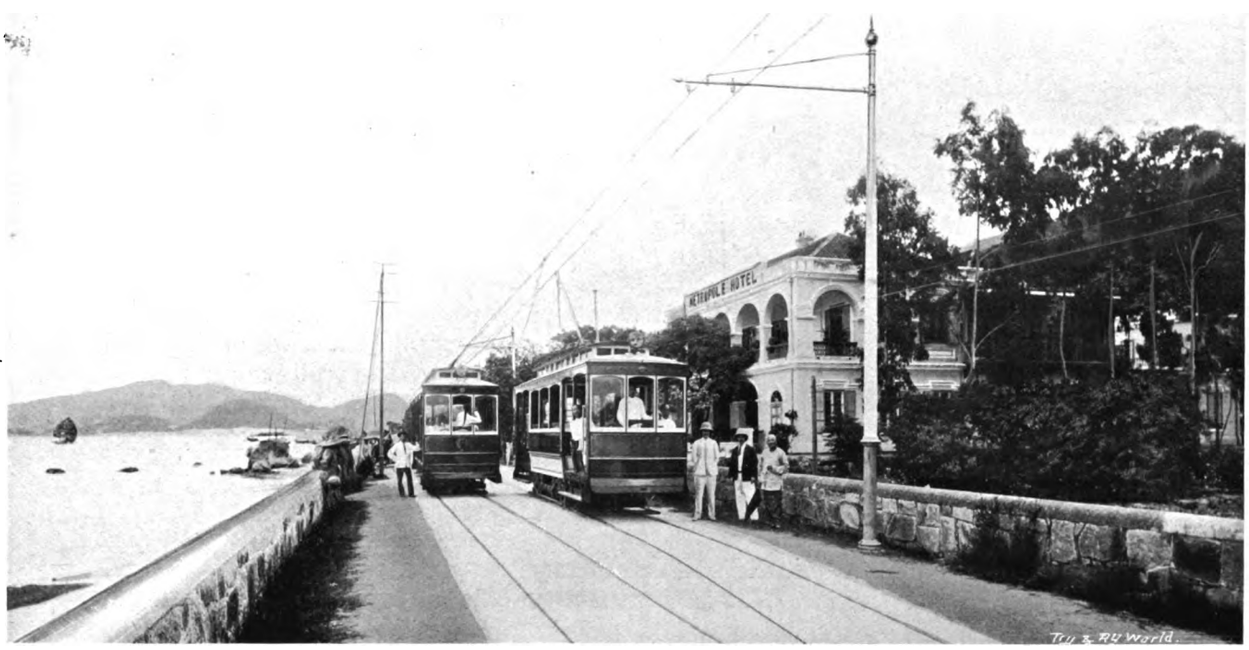
ELECTRIC TRAMWAYS IN HONG KONG.

Although little more than sixty years have elapsed since the island of Hong Kong became a British possession, its rise in importance, both as a commercial and a naval centre in the Far East, has been remarkably rapid. Situated near the mouth of the Canton river, and distant about 90 miles from the ancient Chinese city of Canton, it possesses one of the finest and most beautiful natural harbours in the world. This must have been recognised by the Chinese themselves hundreds of years ago, as the Chinese characters representing the name of the island signify "Good harbour."

The island itself is some 11 miles long, and from two to five miles broad, and consists of lofty uncultivated hills. In the younger days of the colony it was considered a most unhealthy place owing to the virulence of malaria, but to-day the efforts of the Sanitary Board on the one hand, and the Afforestation Department on the other, have completely altered these characteristics. During the summer months the humidity of the atmosphere renders the heat very trying to Europeans, but from September to March the weather is all that could be desired. The population of Hong Kong is estimated at 284,000, and of these 274,500 are Chinese. Its trade is estimated at £50,000,000 per annum. It has excellent dock accommodation, is strongly fortified, and is the permanent naval base in the Far East.

In 1902 an ordinance was passed by the Legislative Council of Hong Kong authorising the tramways to be laid down by the Hong Kong Tramways Electric Company, an English Company with its headquarters in London, and work was commenced in May, 1903, and completed last July. The detailed plans and specifications were prepared by the company's consulting engineers, Messrs. Alfred Dickinson and Company, of Birmingham, who appointed Mr. Harold Hackwood to act as their representative in Hong Kong, as resident engineer in charge of the construction. The contractors were Messrs. Dick, Kerr and Company, of London, who carried out the whole of the work.

The total length of single track is 14½ miles, which is laid in 9¼ miles of route. The gauge of the track is 3 ft. 6 in. with rails of the girder type weighing 86 lbs. per lineal yard. Each rail joint is double bonded with 6/0 S.W.G. copper bonds. The lines within the city are laid for the most part as centre pole construction, but the eastern portion of the route being outside the city boundary, is laid as single line with passing places, and is equipped on the side pole system.



View on Hong Kong Electric Tramways.

With the exception of a short branch line, which runs to the Race Course, the route runs parallel with the water front, and with the exception of a short length at Quarry Bay is practically level. At Quarry Bay a short length of road grading has been done, the original grade of 1 in 10 having been reduced to 1 in 15. Beyond Quarry Bay is the eastern terminus of the line, where is situated the small Chinese village of Shankiwan. Owing to the varying nature of the ground, three forms of permanent way construction have been adopted. Where the ground was solid the rails were bedded on a

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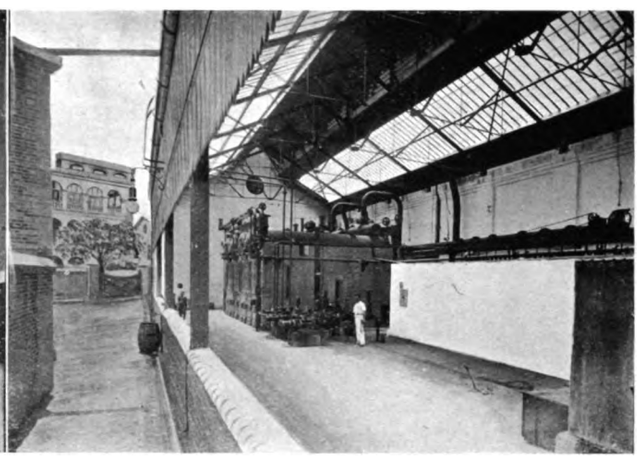
concrete beam 18 in. wide and 6 in. deep; where the ground was not so good, a bed of concrete 6 in. deep and 7 ft. 3 in. in width extending under the whole track and 1 ft. 6 in. on either side was adopted; over doubtful ground which had been recently reclaimed from the sea, this concrete bed was increased to 8 in. in depth. The concrete used was mixed in the proportion of 6 to 1, Portland cement of local manufacture and exceptionally good quality being used. After the rails and the bottom concrete were laid, the road surface was made up to rail level with concrete and finished off with a smooth surface to the proper camber of the road.

The overhead construction has been carried out in a very neat manner, the length of arms on the centre poles not exceeding 2 ft., while the arms on the side poles vary in length, the majority of them being 6 ft. long. The poles are of mild steel, 28 ft. 3 in. in length, 7 in. in diameter at the base, tapering to 4 in. in diameter at the top. They are set 6 ft. in the ground in a solid block of concrete. Within the city, ornamental base castings greatly add to the appearance of the poles, which is still further enhanced by the addition of wrought iron scrolls on the bracket arms.

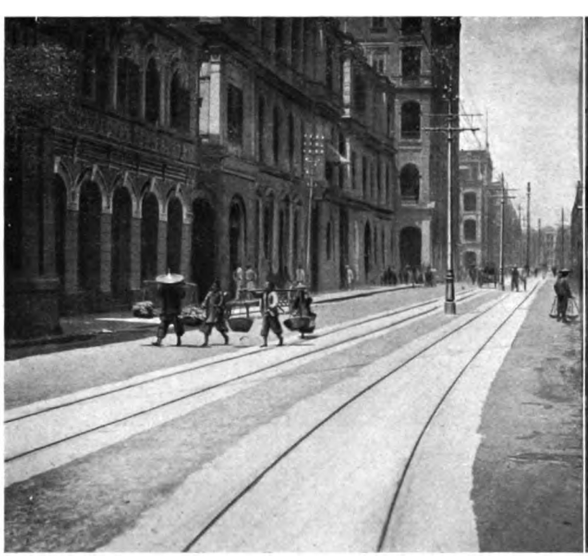
The trolley wire is divided into half mile sections by means of section insulators, and at each of these points the main feeder cables are tapped and current is taken to supply each section of trolley wire; this is accomplished by running the feeders through a feeder pillar containing the necessary switches and fuses; the connections from the feeders to the trolley wires are made with rubber covered 37/16 cables, carried up inside the poles and along the sides of the bracket arms. The pressure at the trolley wire is 500 volts. A lightning arrester is provided in each feeder pillar, and also a telephone giving direct communication with the power house.

The feeder cables were supplied by Callender's Cable and Construction Company, and laid on the solid system. In addition to the main feeders running east and west from the power-station, a return 37/13 booster feeder has been laid in each direction to within a mile of

Car Shed at Hong Kong.



Interior of Boiler House.



A Street View in Hong Kong.

Construction of the Tramways.

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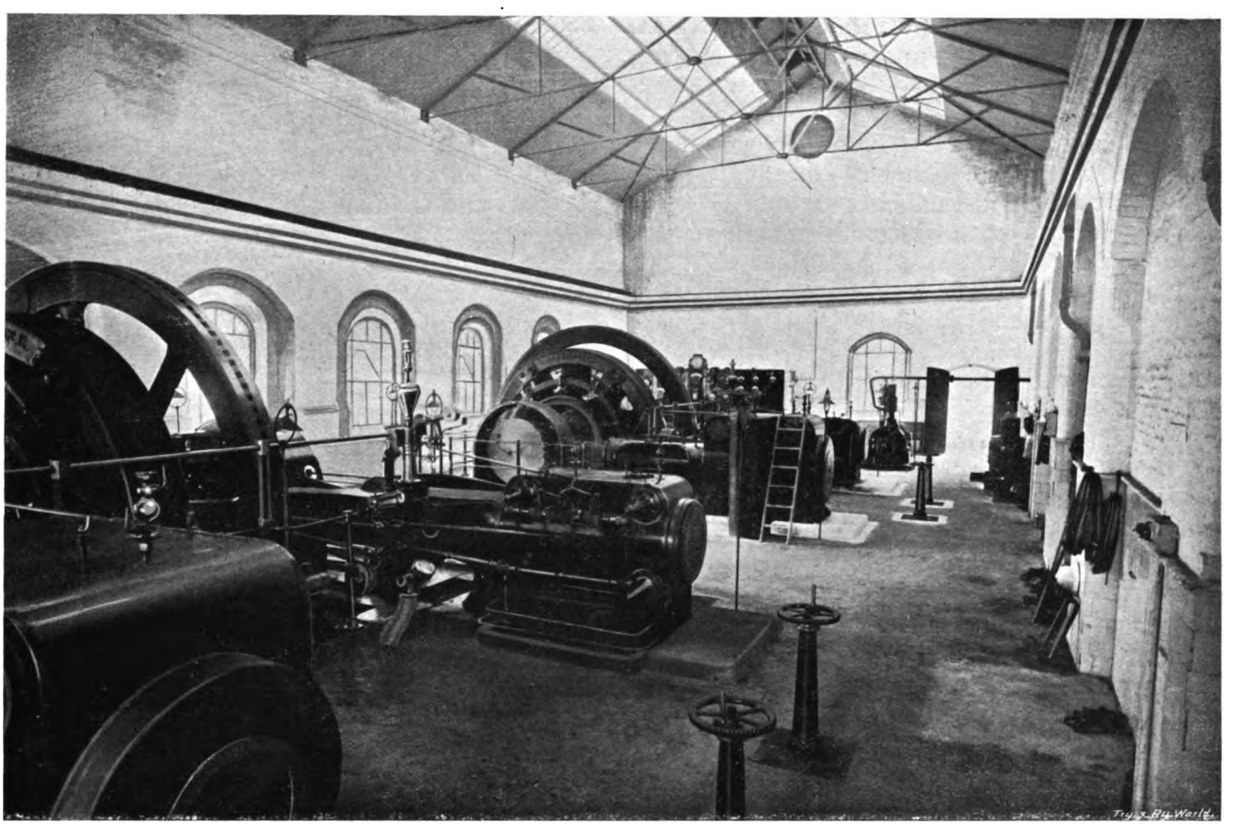
the two distant termini, where it is connected to the rails; it also makes connection with the rails at each feeder pillar. A three-core pilot cable has also been laid from the power-station to each terminus, one core being connected up for testing purposes and the remaining two cores being used for telephone service.

The generating station is as nearly as possible in the centre of the system, a convenient site having been obtained alongside the Bowrington Canal, from which water for condensing purposes is obtained, and which enables coal and materials to be delivered by barges direct on the site. The only objection which could be found with the site lay in the fact that a very few years ago it was reclaimed from the sea, and consequently no good foundation could be obtained for either buildings or machinery; however, as it was the best site obtainable in all other respects, this difficulty had to be overcome, and efficient foundations were obtained by the driving of over five thousand piles. These were spaced so as to support the whole weight of the buildings themselves, the ground, which greatly varied in solidity, being left as an additional factor of safety. China fir poles, 15 ft. in length and 5 in. in diameter, were used for the buildings and machinery, special 7 in. poles, 18 ft. in length, being used for the chimney foundations.

The depôt comprises engine room and basement, boiler house and coal store, car shed and machine shop, smithy, paint shop and carpenters' shop, and offices.

The engine room, which is lofty and well lighted, contains two Dick-Kerr continuous current, direct-connected generators, of the multipolar type, compound wound, giving a potential of 550 volts, and running at 100 revolutions per minute. They are designed to run either separately or in parallel. The generators are keyed direct on to the main shaft of the engines, which are of the horizontal cross compound type, each engine being equal to a maximum load of 557 B.H.P. The engines, built by Yates and Thom, are each provided with a Wheeler surface condenser of the Admiralty pattern, and may be worked either condensing or non-condensing. The condensers are fixed in the basement below the engine room, as also are all the steam and other pipes, thus leaving the engine room free and open. Circulating water is obtained for the condensers from the Bowrington Canal, which is alongside the site, the water first passing through sumps fitted with gratings and strainers to exclude obstructions. In addition to the two traction sets there are two smaller plants for arc and incandescent lighting of the depôt, one set being driven by a small high-speed engine, and the other by a motor running from the 500-volt circuit. The lighting circuit is supplied at 100 volts pressure.



Interior of Power Station of the Hong Kong Electric Tramways.

The switchboard, which is of Dick-Kerr's standard type, consists of nine panels. It includes a main station panel, two generator panels, two feeder panels, one Board of Trade panel, and three lighting panels. The main

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station panel contains recording instruments of the latest pattern, including a recording wattmeter shewing the total output of the station. The Board of Trade panel is arranged for receiving test wires from different parts of the line, and is provided with instruments for making all the tests required by the Board of Trade. An overhead travelling crane is provided capable of lifting and traversing in any direction a load of ten tons over the whole area of the engine room.

The boiler house, which is at a lower level than the engine room, contains two double-drum water tube boilers of the Babcock and Wilcox type, arranged to burn ordinary Japanese engine slack. Each boiler has 3,654 sq. ft. of heating surface, evaporates 12,000 lbs. of water per hour, and works at a pressure of 160 lbs. per sq. in. In addition to the steam and water gauges, each boiler is fitted with a spring safety valve and a dead weight safety valve. Water is supplied to the boilers by two Blake and Knowles feed pumps which take water from either the storage tank or the hot well, and feed the boilers either direct or through a Green's economiser. In case of mishap the economiser may be cut out, the flue gases being conveyed to the chimney by means of a bye-pass or auxiliary flue, and the feed water being pumped direct into the boilers without passing through the economiser tubes. Two feed water filters are supplied, and all water passes through one or the other of these before entering the boilers.

The chimney, which is circular, is built of brick, and is 153 ft. in height. As Chinese bricklayers are unaccustomed to this class of work it presented greater difficulties in construction than any other part of the work, and as Hong Kong is subject to typhoons of noted severity, exceptional care had to be taken with both the foundations and the building of the shaft. With the exception of the foundations and the chimney cap, the whole of the brickwork is built in lime mortar of special composition, as is also the brickwork of the buildings.

The car shed, which is a rectangular building 220 ft. in length, contains six lines of track and gives accommodation for 35 cars. The roof is of iron, in two spans, partly glazed and provided with louvres, giving plenty of light and ventilation. Inspection pits run the whole length of the shed. There are 26 single-deck motor cars, 10 being of the combination type, with an enclosed portion in the centre and an open platform provided with seats at either end. The remaining 16 cars are of the open cross bench type. The overall length of the cars is 29 ft., the total width is 6 ft. 6 in., and the wheel-base 6 ft. 6 in. The combination car has a seating capacity for 32 passengers, and the cross-bench cars for 48 passengers. Each car is mounted on a truck of the Brill 21 E type, and is equipped with Dick-Kerr 25A motors, the standard metallic shield blow out controllers, and the usual hand brakes. The trolleys, which are of the lateral type and provided with a swivel head, are 16 ft. in length, and enable the trolley wire to be fixed ten feet away from the centre of the track where necessary. The car bodies were built at Preston by the Electric Railway and Tramway Carriage Company, and were shipped to Hong Kong in sections, where they were fitted together and connected in a very short space of time. At one end of the car shed is a well-equipped workshop, containing screw cutting gap-lathe, wheel lathe, wheel press, and drilling machines, the whole being driven by a 500-volt motor. A suitable smithy, carpenters' shop, and paint shop are also provided.

Before the introduction of electric traction into Hong Kong, the popular ricksha drawn by a Chinese coolie was the principal means of locomotion, and of these nearly 2,000 were licensed for hire, in addition to a large number owned privately. Although rather slow, the ricksha is hard to beat for general convenience; the fight for supremacy between the out-of-date ricksha and the new electric car will be of interest, but it must of necessity end in the victory of the latter. As this is the pioneer system of electric traction in China, it is to be hoped the venture will meet with a well-deserved success, and that electrically equipped lines will shortly be laid in other parts of the Celestial Empire.

BOOK NOTICE.

STEAM AND STEAM ENGINES.†

This little book has now arrived at its tenth edition, and the persevering author constantly adds to it anything new, and subtracts out-of-date material. Of the out-of-date matter partially subtracted and otherwise amended is the reference to the cross tubes in the flues of shell boilers. This has been brought to date, and a coloured diagram of a modern Lancashire boiler has been inserted, showing the setting, mountings, etc. In his next edition we should advise the author to consider whether the progress of the turbine will not warrant an extension and modification of the section on turbines, and we certainly think he should now give a greater space to superheating, and explain its action in the engine.

Perhaps with advantage the indicator diagram might be illustrated, as it is obtained small from a high-speed engine, and a note or two made of some modern forms of indicator, so as to familiarise students with the changes made in practice.

As our readers will generally be aware, the scheme of the author's books is to furnish a series of lectures with questions on each lecture, so that whether in class or under his own tuition a student can gauge the extent to which he can apply his knowledge by endeavouring more or less successfully to answer the questions. Each question, when practicable, has its answer attached, and the student cannot do better than get this manual as his first book on the steam engine.

RAILWAY COAL CONTRACTS.—The Midland and North Eastern Railway Companies have arranged with the South Yorkshire Collieries for their next year's supply of coal. The price is 8s. 3d. per ton, which is the lowest which has been paid since 1898.

† "Elementary Manual on Steam and the Steam Engine," by Andrew Jamieson. London: Ch. Griffin and Company, 1904.

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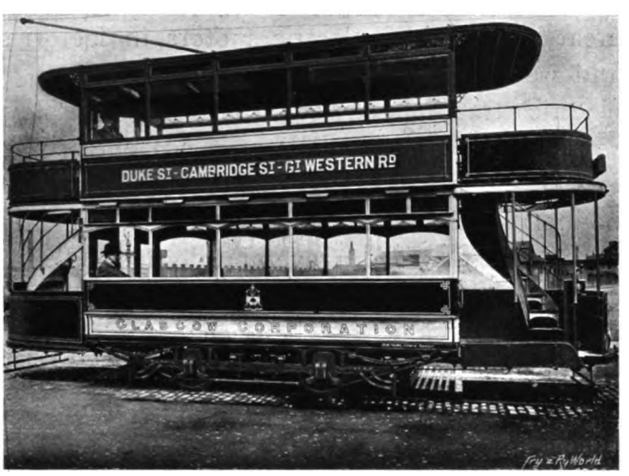
THE GLASGOW STANDARD TOP COVERED CAR.

We give herewith an illustration of the covered double-deck car recently built by the tramways Committee of the Glasgow Corporation, and ultimately adopted as their standard type. In designing this car, an effort has been made to secure comfort and usefulness in a very high degree, while preserving as far as possible the good appearance of the car. It was only after experimenting with several designs and over a considerable period that Mr. John Young arrived at this design and form of construction. In these experiments, fixed roofs and roofs with movable panels, opening balanced side windows, and fixed side windows with hinged ventilators on both sides and ends, were tried in various combinations.

The conclusion arrived at by the Tramways Committee is that, taking everything into account, the fixed roofs and fixed windows with ample ventilators are best adapted for the requirements of the service. There is, of course, much less maintenance with closed roofs and windows. The side ventilators are geared in a simple manner, so that on either side of the car they can all be opened or closed by one operation.



Glasgow Top-Covered Car.

Along with the end ventilators they provide ample ventilation for the car, and are entirely under the control of the conductor.

In the first experiments, attempts were made to retain the existing easy stairways. This meant, however, closing in the entire upper deck, and the effect was to give the car a stiff and top-heavy appearance. Besides, there is a general feeling in favour of retaining outside seats for a few passengers on the canopy over the platforms. To admit of this it is necessary to enter the closed upper deck from the centre instead of at the side as in the case of the existing stair. It was, therefore, resolved to adopt a half spiral stair. Mr. Young, however, could not get such a stair to satisfy him upon the present regulation platform. It was, therefore, decided to lengthen the platform by a foot. Thus a first-rate stair is provided which in no way obstructs the motorman's view, and avoids any clashing of lower and upper deck passengers. The controller and brake handles are so placed in front that the motorman occupies the most commanding position, and there is space for a glass shield over the dash in front should it be wanted at any time. To effect these improvements the new car was designed and built, which is here reproduced.

The car body is exactly the same as the present standard car, and is seated for 24 inside. The cover, it will be observed, is the same length as the car body, and, as the canopy extends over the full length of the platform, outside accommodation is provided for 5 passengers at each end. The seating capacity of the covered portion—with the absence of the trolley standard and a rearrangement of the seats—is 32, thus giving total seating accommodation for 66 passengers. The construction of the upper roof in the present standard cars gives a clear head-room of 6 ft. 1 in. The side pillars and roof ribs are of polished ash, and the lining of narrow polished pitch pine and cherry alternately. It will be observed that the step to the platform is made to fold up. From an artistic point of view the lengthening of the platforms and correspondingly of the protecting sheet and railing round the canopy over the platforms, gives an appearance of greater weight to the body of the car, and, in effect, reduces the proportions of the top cover—which have been actually reduced by the lighter side pillars required for the fixed windows—all tending to give the car a more graceful appearance. One hundred of the present standard cars are being altered and covered practically to this design in the Car Works at Coplawhill, and a proportion of covered cars will very soon be placed on each route. The streets are at present being lowered under some 14 bridges, so as to give the necessary height for the covered cars. In all probability all the standard cars will in turn be similarly altered, and the additional one hundred new cars sanctioned some time ago will be constructed on the same lines.

TRAMWAYS ASSOCIATION AND SPEED LIMITS.

Letter to the Board of Trade.

The following letter from Mr. E. Benedict, secretary of the Tramways and Light Railways Association, to the President of the Board of Trade has been published in the Association's official circular:

The Council of the Tramways and Light Railways Association have instructed me to communicate to you their strong opinion that the speed limits on tramways should not be more stringent than the limit for motor-cars, and especially for motor-omnibuses on the same road.

They desire me respectfully to point out that under Section 9 of the Motor Car Act, 1903, the limit for motor-cars is 20 miles an hour, unless (a) on the petition of the Local Authority, (b) by the order of the Local Government Board, a lower limit is enforced, and this limit can never be less than 10 miles an hour.

This enactment is a recognition by the Legislature of the obvious scientific fact that a higher speed is now practicable for road traffic, with due regard to the public safety, than was heretofore supposed to be desirable, and it affords a good reason for revising all previous bye-laws fixing the limit of speed on tramways.

The tramway owners are now, in many cases and at vast expense, furnishing a wider road and smoother track for the use of competitive motor-omnibuses, which are not subject to the same limitations of speed. There is no scientific reason why, except perhaps on very sharp gradients, tramcars should not safely be allowed to run as fast as motors; there are, indeed, many practical reasons to the contrary: the tramway owners are always ascertainable and always responsible in case of accidents; they only run on a defined track, and that, generally, at a good distance from the footway; the danger of the roads is much increased by the practical necessity for motor-cars to swerve aside in order to pass tramcars creeping along within the legal limits.

My Council respectfully suggest that the Board of Trade should notify that, as a general rule, they will adopt the limit of 20 miles prescribed by the Legislature in the case of motor-cars, and that they propose, subject to any exceptions that may be necessary in special cases, to modify their regulations in this sense. This would leave unaffected any bye-law of Local Authorities prescribing less speed but, when sanctioning fresh bye-laws, the Board of Trade would, it is assumed, have regard to the same considerations.

The Board of Trade are, of course, aware that in the case of tramways, as in the case of motor-cars, the fact that the car is running within the legal limit is no answer to a claim in case of accident. The tramway owners would still have every reason for restraining their drivers from recklessness or carelessness.

My Council believe that this matter urgently demands the attention of the Board of Trade, in the interests both of the travelling public and of the private or municipal capital embarked in tramways.

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THE

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We shall be pleased to receive at all times articles, papers, notes, and correspondence on subjects of interest to those concerned in the financial administration, construction, or management of tramway and light railway undertakings. Particulars as to the issue of specifications, the progress and completion of contracts for new work, and suggestions for improvements in all branches of tramway enterprise will receive special attention.

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Business Prospects.

The past year cannot be said to have been a particularly prosperous one for manufacturers of machinery and plant required for electric traction purposes. The volume of work appears to have been pretty fair, but the prices obtainable left much to be desired from the sellers' point of view. In any year one hears stories of work being undertaken at merely cost price, but tales of that sort seem to have been much more numerous of late. The period has been a most favourable one for the purchaser, and a good deal of advantage has been taken of it. In the long-run, however, times of low prices are not good even for the buyer of machinery, because unremunerative work tends to extinguish weaker firms. Competition is thus lessened, and when brisk times return the buyer has to pay higher prices than would otherwise be the case. It is perhaps no consolation to the manufacturer that other branches of industry have suffered also, and he can only hope for the speedy return of brisker trade. The prospects of that in the immediate future point in a somewhat different direction from the state of matters in the recent past. So far as new work is concerned in the great towns, apart from London, there will be much less to do for a few years than has been the case. Power-stations, machinery, tracks, and rolling stock have been supplied, and further work must lie in the direction of extensions, and, by-and-by, of renewals. Further development may, however, be looked for in the direction of interurban tramways. A new and probably a very large field is now beginning to open, first in the supply of machinery for the power-stations of large electric power supply companies, second in providing high and low tension mains for distribution purposes, and third in the manufacture and installation of great numbers of electric motors in factories and workshops. Then in the development of electric traction on suburban railways now worked by steam, manufacturers are entitled to expect a great deal of business. It can hardly be doubted that the change which has recently been carried out on several railways will encourage other companies to revolutionise the method of conducting their local traffic. The time may soon arrive when electric traction for long distance runs will be adopted, but that time is not yet.

Progress in Electrification of Railways.

However great the delay may be in the application of electric traction to main line work, the electrification of suburban and branch railways seems likely to proceed with some rapidity. The preliminary or experimental period has already been entered upon, and it is not too early to predict a favourable verdict. In this country the Lancashire and Yorkshire and the North Eastern Railways are entitled to the credit of having first adventured upon the untried way, although the Metropolitan Railways of London have not lagged far behind. The present year will, of course, witness the almost entire withdrawal of steam locomotives from the latter lines, and it will also see the installation of the Great Western Railway well advanced. Meanwhile we may look for the publication of facts bearing on the economical aspect of the working of the Liverpool and Southport and the

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Newcastle and Tynemouth railways. It is already rumoured that the results in both cases are proving satisfactory to the companies concerned. The station at Formby has for some months been in full working order, and its output is now the largest of all stations in the country, exceeding that of the Central London Railway, which for some time was in this respect the leading station. Of the train service from Liverpool to Southport, only admiration can be expressed. It is immensely more agreeable from the passengers' point of view, and the railway officials are, we believe, agreeably impressed with the flexibility and certainty of the electric equipment. Traffic on the line, particularly at the busy junctions near Liverpool, is dense, and the local conditions have afforded a very severe test. If, as we expect, the financial results prove to be equally good, the Lancashire and Yorkshire Company's enterprise will have supplied other railways with a strong incentive to consider very carefully the question of a change of motive power. On Tyneside the electric railway service is of a less ambitious character, but useful information is being obtained from it with reference to local services. The only drawback in either case has been the accidents caused by the third rail. When the lines were first opened it was not unnatural that some lack of care should be shown by pedestrians wandering on the line; but the difficulty will diminish as the possible danger becomes better known. A good deal of the newspaper outcry has been due to an exaggerated idea of the danger, and to the preconceived notion that appears to have prevailed in some quarters that the third-rail system would shortly be superseded. Quite the contrary is probably the case, and it is satisfactory that the Board of Trade has not been led to take any action prejudicial to the further application of the system. Since the third rail was adopted on the important routes to which we have referred, the New York Central has decided to apply it to its lines for fifty miles from New York, an installation which will be by far the most extensive application, as regards the volume of traffic to be dealt with, of electric traction to railway working. The progress of that undertaking will be followed with great interest, and it is not improbable that it will have far-reaching consequences for American railways.

Improvement in Traction Apparatus.

The past year may with some accuracy be described as the year of the steam turbine. Both in this country and America various forms of the turbine have been put in service at important power-stations, and extensive orders for them are now being executed. At Carville station, near Newcastle, at Lister Drive station, Liverpool, at the Metropolitan Railway Station at Neasden, and at some smaller stations steam turbines are in regular service, apparently with much success. Leeds Corporation has just ordered a large turbine of the Curtis type, while at Chelsea station, the great installation which is to supply current for the District Railway and its allied undertakings, some of the large Westinghouse turbines have already been put in position. These latter machines are the largest that have yet been built, and it is gratifying to have the assurance that several of them are running perfectly. It has been no small task to carry through the manufacture of these machines; but the makers have spared neither money nor effort to attain success, and it is a credit to British engineering that the work has been done at British shops and largely by British workmen. When it is remembered that less than ten years ago even quite small reciprocating engines for electric tramway stations were frequently imported, it is astonishing to note the progress that has been made in British manufacturing enterprise. Not less striking is a comparison with, for instance, the equipment of the Leeds tramway station of 1894, or the Great Northern Railway Company's lighting station at Holloway, with the latest designs for such stations as those at Neasden or Carville. From the small belt-connected units of 1892—of which our first volume contains some typical illustrations—to the 7,000 horse-power steam turbine of 1904, is a long road to have come in so short a time. As far as the generating station is concerned we seem, indeed, to have reached the limit of improvement with respect to economy of both fuel and space. Outside the station, however, important changes may be looked for in the not far distant future. The alternating-current motor has a wide field of usefulness, and it is only by its help that electric tramways may be carried further afield with reasonable prospects of financial success. Progress along this line will

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undoubtedly be made during the present year, and the year may indeed see changes in this respect equal to those made during the past twelve months in power-station equipment. For existing tramways, there is the prospect of increased economy in the regenerative control system, to which considerable attention has been given in our pages during the past year. The system is chiefly attractive, no doubt, to companies working routes of light traffic and more or less severe gradients; but it is quite possible that the utility of the system may have wider application. On the numerous minor improvements in equipment we will not touch; for progress in these details is constant, and to narrate them would transcend the space of a casual note. In every department of electric traction change is, indeed, the present characteristic. Finality is by no means reached, and it would require a prophet of more than the average assurance to describe the electric railway of five years hence. Consequently it were wise to look well to depreciation and reserve funds, that they may be available when installations now new grow prematurely antiquated.

Rear Lights on Road Vehicles.

The necessity for insisting on all vehicles showing rear lights is becoming more and more realised not only in the United Kingdom but also in other countries. In India, the crawling and wandering bullock-cart, the prototype of our own market wains, has for many years past been obliged to show an all round light—all the more necessary now that the loud creaking of these vehicles, for want of lubrication, has been stopped by law, rendering them noiseless as well as invisible. On the continent draught animals almost invariably wear *grelots* which give warning to people travelling in the opposite direction or being overtaken but are useless to overtaking vehicles. The Union des Tramways de France is moving in the matter and has inquired of the Tramways and Light Railways Association what is being done in this country. In France, the timber lorries, with two enormous wheels, are obliged to carry a bright red light attached to the rear end of any balk they may be carrying thus, as described by the Secretary of the Union, avoiding the danger, amongst others, of sweeping passengers off the side path, without warning, in rounding corners. The Secretary points out how that accidents are frequent on ill-lighted suburban roads, on which, at nightfall, long strings of market gardeners' wagons wend their weary and wandering way to the markets. The carts keep Indian file, following the leading driver who alone is supposed to be awake; the other drivers make a comfortable bed for themselves by excavating in the pile of vegetables and lining the trench with straw, into which they nestle and cover themselves with a counterpane.

* * *

This description tallies very nearly with Mr. England's experience at Wakefield, and with that described by the Motor Union of Great Britain and Ireland, when an influential deputation interviewed the Hon. T. H. Cochrane, M.P., at the Home Office and spoke in the name of all the users of road motors and cycles. The Under Secretary said in his reply that the simplest and best solution would be a uniform law, applicable to the whole country—which is exactly what is wanted. He thought that any such legislative project must take the form of a private members' bill, and that, on general grounds of public safety, such a bill, if introduced into the House of Commons, would meet with no hostile attitude on the part of the Home Office. Such a bill is now in course of preparation; but it does not follow that it will become law. The only way to secure the passing of the bill is by bringing strong pressure to bear on the authorities, and for this reason we hope that tramway managers will, without exception, support Mr. England in the agitation which he has initiated. The subject has repeatedly been brought forward in our columns and of the advisability of the proposed legislation there is, we are sure, no question.

* * *

At present, a model form of bye-law has been issued by the Home Office for the guidance of local authorities in dealing with the matter and bye-laws in this, or in similar form, have been adopted by a large number of authorities. Altogether, bye-laws on the subject are now in force in 60 out of the 62 counties and in about 300 out of the 324 boroughs in England and Wales. In only a few cases are red rear lights required by the bye-laws to be provided for *all* vehicles. That the form at present issued by the Home Office does

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not ensure the safety of the traffic overtaking slow-moving vehicles is evident. Paragraph 33 of the model bye-laws only refers to rear lights as follows:

"If the lamp or lamps [*fixed in front of the vehicles*] are so constructed as to permit a light to be seen from the rear, that light shall be red. Also if the vehicle is used for the purpose of carrying timber or any load projecting more than six feet to the rear, a lamp or lamps shall be provided, so constructed and capable of being so attached as, when lighted, to show to the rear a red light visible within a reasonable distance to persons overtaking the vehicle."

Now if this latter rule were only made applicable to *all* vehicles and made compulsory by law, the whole object of the present agitation would be attained, and the market gardeners and, in fact, everyone else might sleep in peace, and without fear of fatal consequences to others and of awkward ones to themselves.

RUNNING POWERS.

I venture to ask the hospitality of your journal to say a few words upon the subject of the paper on the above topic read by Mr. Sellon at the meeting of the Tramways and Light Railways Association on December 1. There are one or two points raised by him which seem to me to demand some comment from those whose knowledge and experience is not confined to the promotion and financing of electric street railway undertakings, but who can speak with the feeling of responsibility acquired by long years of actual management of their working.

Against the principle of "facilities" for the use of each other's lines on the part of two systems, no serious argument can be advanced, but I have never heard one of my colleagues—amongst whom are some of the most intelligent, best known, and accomplished men in connection with street railways—assert that they approve of "compulsory powers." The reason for this is obvious. Whether it be a committee or a board of directors who control, the success or non-success of a line depends in a great measure upon the man chosen by that committee or board to manage the details of the working.

"Compulsory powers," according to the accepted interpretation, mean this: The use of a line by the cars *and crews* of an alien system, the control of the *personnel* of these foreign cars being transferred to the owning company as soon as they enter the latter's territory. The choice of these crews and the discipline (except for the short period they may be within the zone of the owning system) is outside the power or influence of the management of the latter.

Now, no one with any experience of management will question the truth of my assertion that one of the vital necessities for securing freedom from accidents, regularity of running, proper behaviour to passengers on the part of employees, etc., is "DISCIPLINE," writ large. I say it is not possible to exercise this properly in the case of crews not subject to your *entire* control. It would require two men as managers of the two concerns of absolutely the same calibre, the same views and feelings as to the working of their lines to obtain anything like a successful working of the combination. And where will you find this?

If this is admitted (and I feel pretty certain of the reply), can it be fair to a manager to expose him to the anxiety it would entail? There are worries enough attached to the position without such an one being added.

What reasons are advanced by Mr. Sellon and other advocates of "compulsory powers" for their objections to what we call "facilities"?

His remarks upon the point are as follows:

"Changing car crews at a boundary must lead to some waste of time and to delay of the traffic, for clearly there must be a spare or overlapping crew available, or cars in opposite directions must await each other's arrival at the boundary." And then, after giving Mr. Bellamy's interpretation and recommendation of "facilities," he adds:

"Picture to yourself for a moment in the crowded streets of Birmingham a service of cars with a headway of every few seconds, and fresh conductors and drivers popping up and down from the cars arriving or leaving the City boundary, and you have a spectacle worthy of a Drury Lane pantomime."

I believe Mr. Sellon never had the charge of an electric road. If he had, I do not think he would advance such an argument. I ask with considerable confidence if there is one single undertaking in the country where the crews are not constantly changed for relief, and this at points along the line?

On a long section for instance, where two or even three depôts may be situated on the route, the crews change for relief without the slightest delay or inconvenience, and the passengers hardly know it occurs.

If this is so (and on my own lines we do it every day), where is the difficulty at a junction of the two systems which would in any case be a fixed stop?

If no more cogent argument can be produced for substituting "compulsory powers" for "facilities" I am at a loss to understand any man who knows what he is talking about hesitating for a minute as to which of the two is the most workable, and the most advisable in the interests of all parties concerned.

TWENTY YEARS A MANAGER.

AMERICAN STREET RAILWAY ASSOCIATION.—We have received from the offices of this Association (2,020, State Street, Chicago) the report of the twenty-third annual meeting, held at the Transportation Building, St. Louis Exposition, from October 12 to 13, 1904. The volume comprises 300 pages, and is embellished with an excellent portrait of the president, Mr. W. C. Eley, president of the Buffalo Street Railway Company. The papers read and discussed at the meeting dealt with the following subjects: "Steam Turbines," "Steam Turbine Power Plants," "Diesel Engine," and "Transfers." These are given in full in the report.

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SOME COMPARISONS BASED ON RECORDS OF ELECTRIC TRAMWAY ACCOUNTS.

The mechanism of progress is comparison. The ancient Babylonians achieved a high degree of civilization. They possessed a currency and a banking system, but they had no water rate, gas rate, or tramways. Why? If the reasons be probed to the fundamental cause it will be found that they fell short of these and other features of our modern and superior time because they had not the same ready means that we have, by which one man can compare his work with what others have done, and are doing, in the same line of effort, and thus estimate the real value of his results.

Whoso desires to improve his pace gets a pace maker to enable him to make constant comparisons. In former times communications were poor, and workers did the best they could with but little stimulus

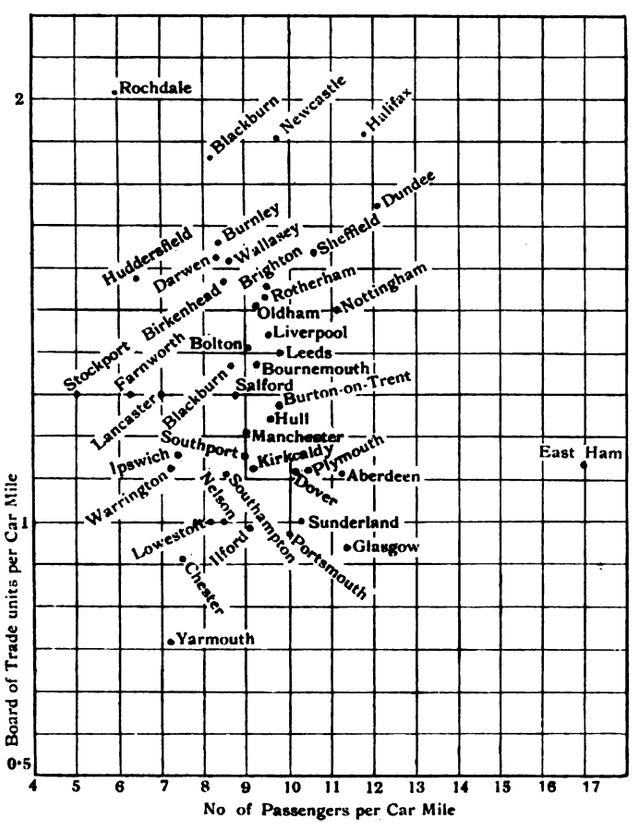

Fig. 1.—1903-4.

or help from comparisons, and progress was slow. But now, what with an enterprising technical press, and numerous associations among men of like aims, comparisons are world-wide, and progress is extraordinarily rapid. It is not conceivable that one city in England or elsewhere working alone, and in technical and financial isolation, could have developed the modern system of electric traction even in two centuries. But, under the forcing influence of facile and wide-spread comparison, electric traction has, in a fraction of that time, permeated to the uttermost limits of the habitable globe.

To repeat, then—comparison is the mechanism of progress—and the immediate question is how to compare the results of the working of the different urban tramways in England so as to disclose in what respects and degrees one excels another in the attainment of the objects for which they were designed. This is very important, because the interest at present exhibited in England in tramway enterprise is accompanied with a good deal of doubt and suspicion, and the only way in which to set these at rest where they are unwarranted, and remove the cause in other cases, is to show, by comparison, where the fault lies and how it may be remedied. This is not a simple matter, as a merely cursory examination of the "Records of Electric Tramway Accounts," published in THE TRAMWAY WORLD of November 10, 1904, will sufficiently show.

In order to effect comparisons, some sort of constant feature must be adopted as a common ground upon which comparisons can be made. But of the 46 columns which this record of accounts comprises, one and all exhibit the most discouraging variations and diversities. This is due, in great part, to lack of uniformity, both in keeping and presenting accounts. Comparisons of capital expenditure are rendered almost futile for this reason. Nor is it possible to draw a satisfactory inference as to what proportion of income should be set aside for depreciation and renewals, according to the united wisdom of the managements concerned.

Another reason for the variations and diversities that all the columns exhibit, is the very mixed motives with which tramway enterprises are set on foot in the first instance, and subsequently conducted when complete. Quick transit, or cheap transit of passengers, introduction of business into the town, simplification of housing problems, will occur at once to all, as among the most ordinary desiderata brought forward.

Under these circumstances it is perhaps too much to expect any basis of comparison offering a reasonable degree of constancy among the columns in which money is involved. It is true that money comparisons do sometimes offer a false appearance of regularity, but it is always one that will not bear examination when solid ground for comparison is sought. For example, of the 46 columns in question, the one in which the average variation from the mean is least, is, "Average fare per passenger." But this is obviously an accident of our coinage system, and only serves to prompt the reflection that if, at any time, our coinage was decimalised by making a penny one tenth of a shilling instead of one-twelfth, the tramways of England would be among the concerns most disturbed.

Other false appearances of uniformity in money columns owe their existence to the fact that ratio of the gross receipts to the gross expenditure, when interest, sinking fund, depreciation, renewals, and profit, are added to the latter, is constant and equal to one. Obviously, there is nothing to be got out of this.

Turning, therefore, to the columns in which that most variable factor, money, is absent, it is instructive to note that, "Passengers carried per car mile," offers by far the greatest regularity. The average deviation from the mean being less than 25 per cent. Now the number of "Passengers carried per car-mile," is not necessarily the same, and may be very different from the average number of passengers in a car; but the two are very closely related, so that the constancy of the former figures may be safely ascribed to the readiness with which the latter attracts the attention of managers and superintendents.

"The consumption of Board of Trade units per car mile," is the column which, after the above, shows the greatest regularity. The average deviation from the mean is in this case over 33 per cent. That is more than one-third instead of less than a quarter.

The Board of Trade units consumed per passenger, is a column that does not appear, but the data for obtaining it are available, and it will be seen that the figures show greater irregularity than the Board of Trade units consumed per car mile, the average deviation from the mean being over 40 per cent. On the face of it, the power consumed per passenger

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might be expected to be more constant than the power consumed per car mile, since it is usually more expensive in power to stop the tram to take up and set down a passenger than to carry him. Looking into the figures, however, it soon appears that with trams run full, stoppages are less frequent, and the number of persons availing themselves of a single stoppage greater, thus reducing the consumption of power per passenger.

Taking now the columns exhibiting the greatest regularity in the figures they contain, an instructive diagram may be formed by combining the two; showing clearly the results already referred to and suggesting many other useful comparisons. In Fig. I. the ordinates represent Board of Trade units per car mile, and the abscissae represent passengers per car mile. The dots in front of each name indicate the position of the towns referred to. It will at once be seen that the greater regularity of the "Board of Trade

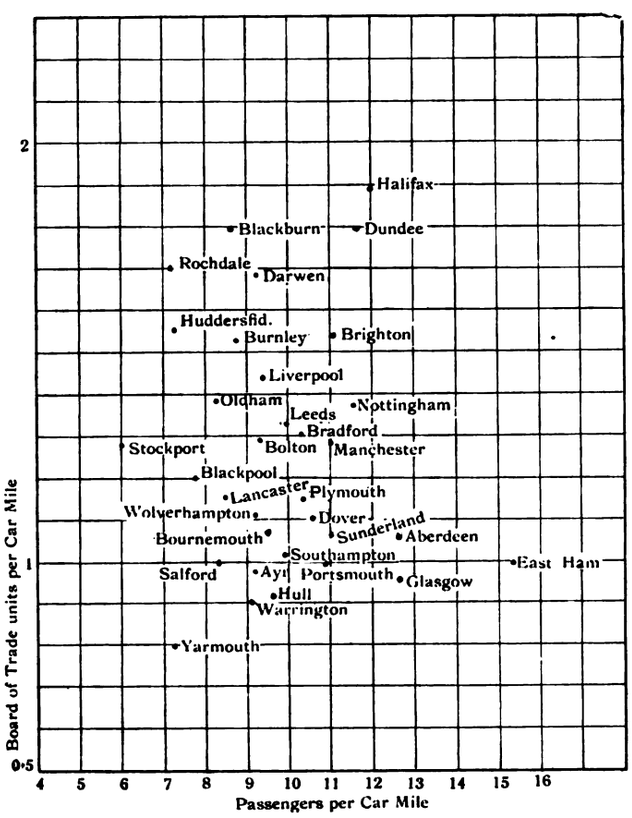

Fig. 2.—1902-3.

units per car mile" compared to "Passengers per car mile" is in a good measure explained by variations in the average of gradients, since the hilly towns appear for the most part at the top. Spots in a line with the left hand bottom corner of the diagram expend the same amount of current per passenger. It is interesting to note that Warrington, Ipswich, Salford, and Bournemouth are alike in this respect, while Glasgow and Liverpool differ greatly, probably because the latter provides a more frequent service of trams. Again, permitting the number of passengers per B.T.U. to be fixed by Manchester as we pass to Southport, Bournemouth, and Rotherham, and in that order, the increase of current is proportional to the increase of passengers.

Other interesting points of difference and similarity are suggested by the diagram, and there are discrepancies which can only be accounted for by special conditions of the service in the towns in question. But the effect of a general survey is to emphasize the fact that though the aims of different tramway enterprises are far from identical, there is still much to be gained by comparisons in cases where likenesses of gradients, size and speed of car, etc., are sufficiently close to render them practical.

Fig. II. is a similar diagram showing the position of some of the same towns for the previous year, and the changes are worth noticing. They are very various. The peculiar position of Yarmouth, Stockport, Rochdale, Halifax, and East Ham were, it will be seen, but more pronounced: while others were only moved nearer to the common centre of them all.

HIGH-SPEED ELECTRIC CARS.

In the latter part of 1901, the Boston and Worcester Street Railway Company commenced the construction of a high-speed electric railway, which is now completed and in operation, and extends in almost a straight line between the two cities, a distance of forty miles. The towns and cities within a radius of fifty miles or more of Boston have been connected for a number of years with a network of tro ley systems, and it has been possible to go from Worcester to Boston by a circuitous route. The new road takes passengers from the Park Street subway station, Boston, coming from any point on the immense system of surface and elevated lines of the city, and carries them to Worcester for a fare of 35 cents (17½d.), with a free transfer ticket, to any part of the large system of the Worcester Street Railway. The road has a double track for the entire distance, and a large part is on private right of way, permitting high speed to be attained, so that the whole distance is covered in about two hours. The towns and cities along the route aggregate a population of nearly one hundred thousand, and, including the cities of Boston and Worcester, it is estimated that a population of about one million is served by the road.

The rolling stock consists of high-speed interurban cars, ten of which have recently been delivered by the J. G. Brill Company. Some of these cars are of the semi-convertible Brill type, with windows that may be raised into roof pockets, leaving the entire space between the window sills and the letter boards clear, so that in warm weather it is practically an open car. The windows at each end are extra wide, being 3 ft. 7 in. from centre to centre of posts, while the other windows are 2 ft. 10 in. from centre to centre of posts. Longitudinal seats at the ends accommodate six passengers each; they have 19 in. backs. The transverse seats are 36 in. long, with 22 in. backs and comfortable head-rolls. The seats at the ends are placed longitudinally to increase the standing space near the doors, and thus prevent crowding at these points. The total seating capacity is forty-eight. Not having wall-pockets in the side walls the window sills are permitted to be extra low, the standard practice of the builders being 24⅝ in. from floor to top of sill. Another advantage claimed for this car is that the ends of the seats are brought against the lining panels, which are set several inches within the line of the posts, thereby increasing the width of aisle, which in this car is 22 in. The windows may be held open at different heights; five stops are provided in the runways so that passengers may admit as much or as little air as they please. The vestibule sashes are arranged to drop into pockets. The car bodies measure 32 ft., and 41 ft. 6 in. over the vestibules; from end panels over vestibules, 4 ft. 9 in. The trucks are Brill 27 F E 1, with 4 ft. 10 in. wheelbase, and solid forged side frames. A car and trucks with electrical equipment, including train control apparatus, but without motors, weighs 35,660 lb.

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LONDON UNDERGROUND ELECTRIC RAILWAYS.

Visit by the Tramways and Light Railways Association.

The Tramways and Light Railways Association on December 16 paid a visit to the power-stations of the Great Northern and City Railway and the City and South London Railway, and were afforded an opportunity of inspecting the plant and equipment. The arrangements were made by Mr. Benedict, the energetic secretary of the Association, with Mr. R. P. Brousson, engineer and traffic manager of the Great Northern and City Railway, and Mr. Thomas C. Jenkin, general manager of the City and South London Railway, and everything possible was done to make the inspection agreeable and informing. The party assembled at two o'clock in the afternoon at the Moorgate Street terminus of the Great Northern and City Railway, where they were met by Mr. Brousson. They proceeded by the railway to Essex Road to inspect the power-station in Poole Street, but before starting they were taken into the tunnel beyond the Moorgate Street platforms and shown the fine piece of special track work there. A cross-over has been provided so that trains may enter at or leave from either platform. This cross-over, like others on the line, is 150 ft. long, and this length gives a good lead of track, allows of curves of large radius, and minimises the wear of the rails. Owing, however, to the resulting fineness of the angles made at the points the gaps in the conductor rails have to be longer than usual, and it was found that with the ordinary four collector shoes on a motor car the two leading shoes might be over one gap at the same time as the shoes in the rear were over the gap behind, so that for a short distance no propelling power would be available. (It may be recalled that on this railway both positive and negative conductor rails are used, and that one is outside one of the running rails and the other outside the other running rail.) To overcome the difficulty the motor cars are each fitted with eight shoes, the four additional ones being mounted below the ends of the bogie trucks nearest the centre of the car. In this way contact with the conductor rails is never broken. The Thomson-Houston multiple-unit control employed on the trains was next briefly explained, and the visitors were then taken on in a train, admiring the while the spaciousness of the cars and the large diameter of the tunnels, to an intermediate station, where Mr. Brousson, crowding the members as much as possible into a signal cabin, explained the working of the automatic signalling system which he has elaborated. The operation of this system is referred to in the brief description of the line given below, but here we may note some points as shown and explained to the visitors. In the cabin are arranged pairs of green and red lights corresponding to the starter, inner, and outer signals next to the cabin for each tunnel. These lights are changed as the signals on the line change when actuated by the moving trains. The track rails are bonded for carrying a signalling current of low voltage, and at each signal there is a short section insulated from the rest of the track rails. On a train entering this section, it short-circuits the track rails through its wheels and axles. This actuates a relay, the circuit of which by means of solenoids works the signal lamps in the tunnel and also the recording ones in the signal cabin. The attendant there can thus keep a constant record of the progress and position of each train in his section.

On arriving at the power-station the visitors were shown the leading features; these are briefly described below.* The members first inspected the outside arrangements, such as the coal and ash handling on the bank of the canal, the ventilating shaft going down to the railway, and so forth. They then looked round the boiler house, and, passing on, examined the engine room, power plant, switchboard, etc. On every hand they were struck by the extreme ingenuity with which every available square foot of the limited site had been utilised. Only one of the four generating sets was running as the afternoon load is light, but just as the party were leaving a second set was started to meet the demand created by the evening rush of people suburbwards which was just about to begin.

The party, having returned to Moorgate Street, crossed the road to the passenger station of the City and South London Railway, where they were met by Mr. P. V. McMahon, engineer to the Company. They proceeded to the southern terminus of the railway at Clapham Common, in order to see the very large tubular tunnel in which both tracks and the station platform are situated. While in the case of the Great Northern and City Railway the tunnels are always kept lighted, the City and South London Company only light theirs in case of emergency. This, however, can be done at any time, and almost at a moment's notice. Telephone wires run along the tunnel walls, and the driver of the train has a telephone instrument which he can, whenever he pleases, connect by a couple of hooks to the wires. He can in this way speak from any point on the railway direct to the switchboard attendant in the power-station. The process was illustrated for the benefit of the members of the Association, and scarcely had the word been passed to the driver that the tunnels were to be lighted when the electric glow lamps spaced at intervals along the tunnel wall shone out.

Returning to Stockwell, the party were shown through the power-station. Land is more abundant here than it is at the Great Northern and City station, so that the premises are more spacious. Much interest was aroused by the varied nature of the plant in the engine room, ranging from the large horizontal slow-speed sets to the high-speed engine coupled to a bipolar dynamo. The latter set, now used as an auxiliary, was taken from the Company's old power-station, and it was one of the first direct-driven traction dynamos used in this country. Other bipolar machines, driven by belting in the old station, are now used as motor generators or as boosters in connection with the transmission at 2,000 volts to Islington. A brief description of the installation is given below, but a long illustrated description appeared in this journal for December 12, 1901. An elaborate account of the working of the line was given by Mr. McMahon, in a paper read before the Institution of Electrical Engineers, and published in The Tramway and Railway World of January 14, 1904.

A brief stay was made in the boiler house, but longer attention was given to the repair shops, where all sorts of repairs to motors and trucks were in full swing. The party then separated, well pleased with their afternoon's outing.

The descriptions which follow were supplied to the Association by Mr. Brousson and Mr. Jenkin.

* A detailed and illustrated description of the railway, plant, and equipment, will be found in The Tramway and Railway World of July 10, 1902.

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THE GREAT NORTHERN AND CITY RAILWAY.

The Great Northern and City Electric Railway is a low-level tube railway with one terminus at Finsbury Park, under the Great Northern Railway station, and the other in the City at Finsbury Pavement, with intermediate stations at Drayton Park, Highbury, Essex Road, and Old Street.

The tube is the largest of its kind yet constructed in London, being 16 ft. in diameter; it is, therefore, large enough to take main line vehicles and will, in fact, accommodate the largest English Pullman coaches. The diameter of the station tunnels is 21 ft. in the case of intermediate stations, and 23 ft. at the termini. One of the features of the line is the absence of inflammable material in the tunnels and the platforms. A novel idea was introduced in constructing the running tunnels; for a considerable length of the line three courses of brick were used for the lower half of the "ring," the top half being of the ordinary cast iron segments. This arrangement is due to Mr. E. W. Moir, and gives a more elastic road bed than is the case where iron segments are used throughout.

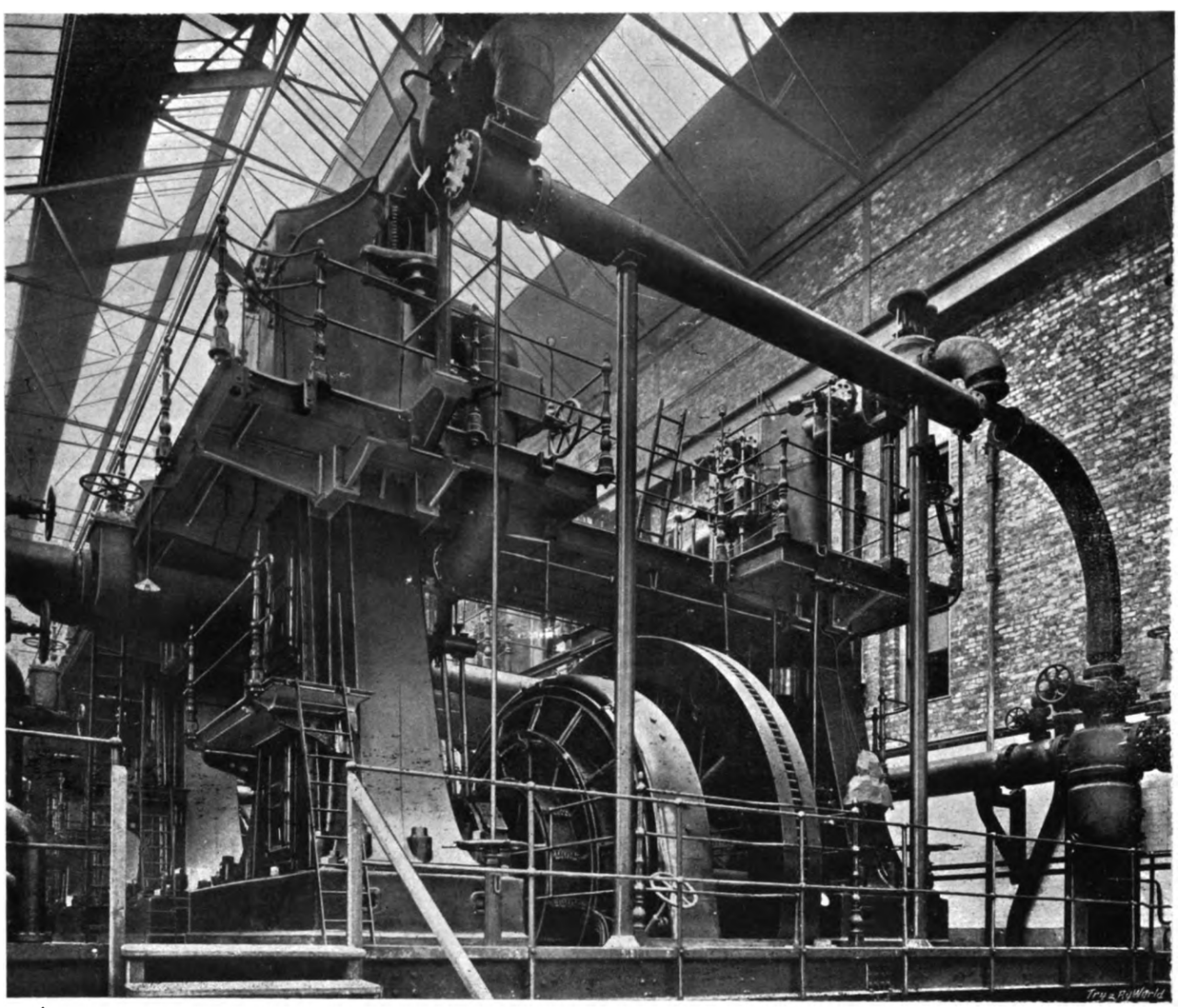
The rolling stock is of two kinds, motor cars and trailer cars, which are made up into trains of various sizes to meet traffic requirements. Each motor car is fitted with two 125 H.P. motors. The controlling gear is placed in a fireproof compartment at the end of the coach. All cars are fitted with the Westinghouse quick-acting brakes, and each motor car carries a motor-driven compressor, which is automatically started and stopped by the pressure of the air in the reservoirs.

The sidings are situated at Drayton Park, where are also the car sheds and repair shops. The latter are provided with all necessary machines and tools for any mechanical and electrical repairs which may be found necessary. The power is transmitted through belting and shafting driven by an electrical motor.

Lifts are provided at different stations for conveying passengers to and from the trains. Those at Moorgate and Essex Road are electrically-driven by motors placed over the lift shaft. Direct-acting hydraulic lifts are installed at Highbury and Finsbury Park stations; the necessary power being obtained from electrically-driven pumps.

An automatic system of track signalling is used with a treadle control. A train entering a section controlled by a signal puts this signal to danger, and locks it at danger until the train passes out of the section, when the controlling relay is energised, and the last coach, which is fitted with a brush, makes a contact on the treadle and releases the signal. The signal in advance must have gone to danger before the treadle can operate the signal in the rear.

The generating station is situated about half-way between Old Street and Essex Road stations, and stands on the banks of the Regent's Canal. The main engine plant consists of four Musgrave vertical cross-compound condensing engines of 1,250 I.H.P., each with standard B.T.H. type generators coupled to the



Generating Unit in the G.N. and C.R. Power Station.

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engine shaft and placed between the high and low-pressure cylinders. These generators are compound wound to give 575 volts at full load. Each engine is fitted with one Wheeler surface condenser to act in conjunction with it. Two auxiliary generators, driven by high-speed Davey-Paxman engines, supply power for lighting throughout the line. These generators are rated at 120 KW. each, and are compound wound to give the same voltage as the main generators, and the main switchboard is so arranged that the lighting can be run off the traction bus-bars if necessary. A small size Wheeler condenser is arranged to deal with the exhaust steam from these sets, and also from three feed pumps.

The main switchboard is of the standard B.T.H. railway type, and is placed at the end of the engine room on a level with the top of the main engines. It has 16 panels made throughout of polished slate. The current is supplied direct to the collector rails by lead-covered cables, which are run down a shaft and along a heading leading to the main tunnels.

The boiler house contains 10 Davey-Paxman boilers, each of which will evaporate 11,200 lbs. of water per hour. These are fitted with Vicars' mechanical stokers which are driven by electric motors placed under floor level at the end of the boiler house. The stokers are fed by shoots from the coal bunker placed at the top of the boiler house and having a storage capacity of 1,000 tons. Two economisers are placed in the main flues, the scrapers being driven by small electric motors. A special Masson Scott oil separator has been installed to purify the boiler feed water. Coal is brought to the power house by barge, and is conveyed to the bunkers by a bucket conveyor after being handled by an electric crane fitted with a Hones grab. All the coal passes through an automatic weighing machine on its way to the bunker. The ashes are stored in shoots placed under the floor of the boiler house, and are eventually taken by the conveyor to a bunker on the bank of the canal, when they can be removed by barge or cart.

Messrs. S. Pearson and Son, Limited, of Westminster, the well-known contractors, who constructed the Blackwall tunnel and are now engaged on the Dover National Harbour and other important works, were the contractors for the whole of the construction and equipment of the undertaking, under the supervision of the consulting engineers, Sir Douglas Fox and Partners. The contractors have undertaken the working of the line for three years after opening.

THE CITY AND SOUTH LONDON RAILWAY.

The Company completed the first section of their undertaking in December, 1890, when they opened the line from Stockwell to the Monument. In February, 1900, the railway was carried from London Bridge to the present City terminus in Moorgate Street, the Monument Station being abandoned, and in June of the same year it went further south, as far as Clapham Common, where it has since secured a large suburban traffic, the trains running in each direction at intervals of two-and-a-half minutes morning and evening, and every four minutes during the rest of the day. The further extension of the railway to the densely crowded district of Islington supplies a direct and important link in the communication between North and South London. From Moorgate Street to Islington the distance by rail is a mile-and-a-half, and, with this section, the total mileage of the Company is 6¼ miles. Between Moorgate Street and the Angel at Islington the stations are at Old Street and City Road, and the journey over the whole length of line is performed in 27 minutes. This extension was opened on November 17, 1901.

The line has subway connections with the Great Northern and City Railway at Moorgate Street and at Old Street. There is also a subway from the Bank station to the Central London Railway, and one at London Bridge, giving direct access from their line to the London and Brighton Company's station. The Islington terminus is contained in an iron-bound tunnel of the same size as that at Clapham Common, namely, 30 ft. diameter—these being the largest in the world—and the long island platforms make ample provision for trains consisting of four coaches. The Company carry 50,000 passengers daily, and run about 600 trains in and out of the termini.

The generating station of this, the first instance of the application of electricity to heavy railway work in the world, at first contained four 400 horse-power vertical engines, belt-connected to four large dynamos which worked the line. Steam was supplied to these engines and the engines working the hydraulic lifts by eight Lancashire boilers. The rolling stock then consisted of 10 3-coach trains and 14 electric locomotives.

With the extensions of the railway to Clapham Common and Moorgate Street, and the further extension to Islington, the question of additional power, and the means of conveying it to the trains, had to be solved. The old line was worked on what is known as the two-wire system (or the simplest method of distributing electrical energy), but this method was no longer applicable, on account of the length of the line, heavier trains, faster service, and the very important consideration of economical distribution, and satisfactory lighting of the carriages and stations.

By the time this change took place there were many examples of heavy electric traction, both on the Continent and in the United States (the then home of electric traction), but the City and South London Railway found it necessary again to become pioneers, and adopted what is known as the 3-wire system; this system was, of course, well known and used for electric lighting, but had not so far been used for traction work on account of the difficulties in maintaining an electrical balance on the two sides of the system. After three years' working on this system, it is satisfactory to know that the company have reason to be pleased with their choice.

Instead of adding to the existing engine and boiler houses, an entirely new building was erected capable of extension to double its present capacity, the old generating station being used for locomotive and repair shops. The new generating station is a steel and brick-work structure 200 ft. long by 90 ft. wide, the engine and boiler houses being practically under the same roof, thus reducing the steam piping to a minimum.

Over the boilers the coal is stored on a steel and concrete floor in wrought iron bunkers, which hold about 1,000 tons. The coal is delivered in carts to a hopper outside the boiler house, from which it is elevated and conveyed to the various bunkers; it then descends by gravity through measuring shoots to the mechanical stokers which feed the boilers. The ashes are in an almost similar manner conveyed to a bunker, where they can be stored or shot into carts as the case requires. The amount of manual labour in handling the coal and ashes is thus reduced to a minimum. The boiler house contains 14 dry-back marine boilers working at 160 lb. per square inch steam pressure, supplying steam through a duplicate range of steel pipes to seven engines direct-coupled to their dynamos; the maximum horse-power being 5,500.

Part of the electrical energy is supplied to the line direct at 500 volts by copper cables; but, in order to ensure an equal distribution of electrical energy along the line, which is necessary for a quick service of trains,

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their steady lighting and the lighting of the stations, two sub-stations, one at London Bridge and the other at the Angel, Islington, have been erected. These sub-stations are supplied from the main generating station at 1,000 volts electrical pressure, and the electrical current is reduced to 500 volts before being supplied to the line. At each sub-station, and at the engine house, large storage batteries are erected to steady the load on the dynamos, and to supply current to the line in the event of a temporary interruption in the engine house supply. The station lighting and current for working the electric lifts are also supplied from these batteries by independent cables, thus ensuring well-lighted stations and power for working the lifts should the supply for working the trains be temporarily affected.

To cope with the increasing traffic more powerful and faster locomotives have been built to haul four-coach trains. Ten new four-coach trains have been put into service upon which no expense has been spared as regards comfort, easy riding, good lighting, etc. The older carriages are gradually being reconstructed on similar lines. The Company's rolling stock now consists of 52 locomotives and 140 carriages, as against 14 locomotives and 30 carriages in December, 1890.

This short description of the railway would hardly be complete without reference to the lifts, which one is likely to forget when talking of a railway. In the case of tube railways they are, however, a very important factor, and unfortunately an expensive one (and further, one for which the average traveller is not likely to give any credit). Altogether there are 38 lifts in use, 12 of which are worked by hydraulic pressure and 26 by electrical energy. A fair idea of the lifting capacity may be formed when one realises the fact that these lifts all working at one time are capable of raising over 2,000 persons, or have a total travel of half a mile up in the air.

In these days of foreign competition it may be a little reassuring to know that the whole of the plant, material, and labour in connection with the building and running of the line since the start is British, and that the Company did not spend any money abroad on their undertaking.

THE RECORD RUN OF THE WESTINGHOUSE WORLD'S FAIR TURBINE.

A memorable incident of the morning following the close of the St. Louis Exposition was the formal shut down and inspection of the 600 H.P. Westinghouse steam turbine generating unit in the Palace of Machinery, after a continuous run of over 3,962 hours—a performance which has had no parallel in steam turbine history. This machine was started on its long run at 9-20 on the morning of Monday, June 20, shortly after its installation at the Fair, and was stopped at 11-32 on the morning of Friday, December 2. During the five and a half months that the unit was in operation it supplied current for light and power throughout the Westinghouse exhibits in the Palaces of Machinery, Electricity, and Transportation. Mr. Charles F. Foster, chief operating engineer of the Exposition; Mr. H. M. Holman, supervising engineer at the Government Exposition gas engine tests; and a number of Westinghouse representatives were present when the engine was stopped. It was found to be in perfect condition, and there were no signs of wear, the bearings still retaining the tool marks as they had come from the shops.

There have been at least two instances on record in America in which piston engines have been run continuously for about the same length of time as that of the record run of the Westinghouse turbine. The remarkable feature of the turbine run, of course, was the maintenance under load of a speed of 3,600 revolutions a minute for such a long period. From 8-30 o'clock in the morning to 10-30 o'clock in the evening, the load carried throughout the Exposition varied from 25 per cent. under load to 25 per cent. over load. The total number of revolutions was 855,792,000.

RESILIENT BED FOR RAILWAY TRACK.

By E. Kilburn Scott, A.M.I.C.E., M.I.E.E.

There is a feeling in some quarters that the very solid form of construction which is characteristic of tramway construction in this country is not altogether desirable, and that troubles with rail joints, etc., might partly disappear if the rails were laid on a more resilient base. All the experience of railway working is in the direction of showing that the road bed should be resilient in character, the many attempts which have been made to do away with wooden sleepers having all ended in failure. In the early days of railway working it was thought that it would be a good thing to support the rails at the joint, but engineers soon found out their mistake, and now all railway tracks have the bridge joint.

Sleepers are used almost exclusively in America, and very largely on the Continent, for tramway tracks, and it is claimed for them that besides giving elasticity they lessen noise, keep the track to gauge, and give easier traction. On the Leeds tramways, where almost every method of construction has been given a trial, it is interesting to note that in some of the more recent work eight wooden cross sleepers are used under each 60 ft. rail, those at the joint being 20 in. apart, this giving a bridge joint as on a railway.

At Hull the rails are laid on longitudinal wooden stringers of creosoted Memel fir, which are in turn laid on concrete. The rails are bolted down to the concrete by bolts spaced 3 ft. apart. Mr. A. E. White, M.I.C.E., city engineer of Hull, has given the writer the cost of the extra materials, taken out at per lineal yard for single track, as follows:

	s.	d.
Wooden stringers	2	5·1
Holding-down bolts	0	5·4
Holding-down plates	0	4·2
Dogs	0	7·6
	3	10·3

In addition to the above, 7½ cubic feet concrete and excavation would cost another 5s. per lineal yard. The platelayers' labour per lineal yard, including points, crossings, and all extras, is 4s. 2d., of which about 15 per cent. is involved in the laying of wood stringers.

In laying the permanent way at Hull the procedure is first to place the rails in position, the stringers are then clamped and dogged up to them, and the holding-down bolts and plates placed in position. After the rails have been lined up the concrete is put in and packed under the stringers, and when it is sufficiently set the holding-down bolts are gone over and tightened up where necessary. The system has proved most successful. There have been no renewals of the hard-wood paving blocks on account of wear and tear, and no blocks have been loosened by movement of the rails. The repairs of an ordinary character to permanent way and paving are practically nil. It may be mentioned that this method of laying on longitudinal wooden sleepers is really a very old construction, as it was used for the original channel rails employed at Leeds, Burnley, etc. In these cases it was found that embedding the sleepers in the ground prevented deterioration. The lasting qualities of wood when laid underground have been well shown recently in the sleepers of the old tramway track near the Elephant and Castle, South London. Some of these sleepers had been down over twenty years, and yet are in perfect condition.

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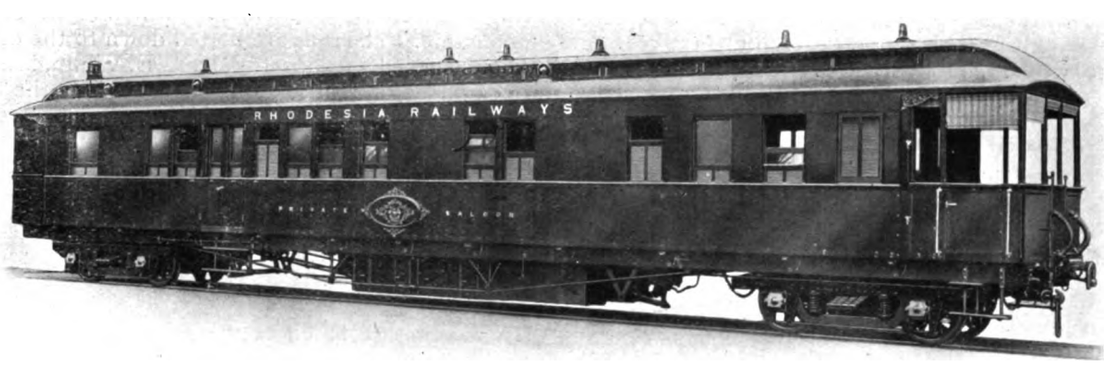
LUXURIOUS CARS FOR THE RHODESIA RAILWAYS.

The accompanying illustrations give some idea of the splendid fittings and furnishings of new type of saloon cars which have just been built by the Electric Railway and Tramway Carriage Works, Limited, Preston. One of these carriages is a saloon intended for the use of private parties travelling in Rhodesia. The general arrangement has been worked out on the most approved principles, under the supervision of Sir Douglas Fox and Sir Charles Metcalfe, Bart., engineers. Every detail has been considered, and nothing is lacking to make travelling as comfortable as possible. The carriage is divided into ten compartments, with a corrider running the whole length, and a balcony at one end and a platform and refrigerator at the other.

The following are the general dimensions:

	ft.	in.
Length over corner pillars	52	10
Length over headstocks	60	0
Centre of bogies	45	3
Wheel-base	6	1
Extreme width over body	8	8
Gauge	3	6

The balcony is provided with a lath seat, having a locker below. Storm curtains are fitted so as completely to enclose the balcony in case of wet or hot weather.



Exterior View of Saloon Car.

The living room is of a fine design, the lower portion below the garnish rail being furnished in fumigated oak, and the upper portion in light oak with carved pilasters, giving support to the roof. The ceiling is of millboard enamelled cream and tastefully decorated. The couch and revolving arm-chairs are upholstered in sealing-wax-red morocco leather. This compartment is furnished with a sliding table, divided into three pieces, the two end pieces sliding under the centre portion. Flap tables, basket racks, electric fan, hat and coat hooks and mirrors are also fitted. The floor is covered with thick linoleum and loose rug.

The bedrooms are finished in light oak, with millboard panel and roof enamelled cream. Below the garnish rail, teak and fumigated oak alternate. In the double bedroom the couch is of ample proportions, and will allow of being converted into a bed. The backs are well padded, and of sufficient height to give great comfort when used as a seat. The upper berth is provided with hammock springs, hinged and fitted with spring catches so as to admit of it being made parallel with the end walls when not in use. This compartment, when necessary, can be converted into a single bedroom by means of a partition of the revolving shutter type which slides up into the roof. The couch and stools are upholstered in sealing-wax-red morocco leather. The room is also provided with flap tables, bevel mirrors, brush and comb rack, etc. The floor is furnished with thick linoleum and a loose rug at foot of lower berth.

There is also a single bedroom which in finish and design is a facsimile of the double bedroom. In addition there is provided a folding wash basin, towel rail, hat and coat hooks, etc.

The bath-room is enamelled dead white throughout, the sides up to the garnish rail being lined with zinc, and above this with millboard. The floor is covered with lead, with a teak greating over it. The fittings consist of an enamelled iron bath for hot and cold water, folding wash basin, towel rack, cork mat, pasteur filter, brush and comb racks, etc.

The lavatories are also enamelled dead white, the sides are lined as in the case of the bath-room. The floor is also similar to that of the bath-room. The fittings consist of w.c. and folding wash basin, towel rail, brush and comb rack, etc.

The luggage compartment is finished in light oak and millboard panels above the garnish rail and below alternate teak and fumigated oak. Shelves for parcels are provided, and the finish of the floor is of thick linoleum.

The servants' bedroom contains two sleeping berths. The upper one, which is covered with canvas and fitted with hammock springs, is designed to lift up, while the lower, which is covered with ratan, is arranged to pull out. The finish of the room is of light oak and millboard panels above, and teak and fumed oak panels below.

The kitchen is enamelled white and is provided with an open and closed coal stove of latest design, having two ovens, water boiler, plate racks, etc. The tables are all covered with zinc. The sink is lined copper and provided with hot and cold water taps, coal bunker, plate and pan racks. There are a glass and china cupboard, shelves and a flap table. Hooks for a hammock for the cook are also provided, and there is a 6-hole bell indicator to the various compartments. The floor is covered with lead.

The platform is arranged for a refrigerator on the most approved principle, being lined throughout with zinc with air space, ice chests, shelves and hooks, etc. A Baker heater is placed on a corner of the platform for heating every compartment in the carriage by means of steam.

Linoleum is laid on the floor throughout the corridor and compartments. The lights in the monitor roof are

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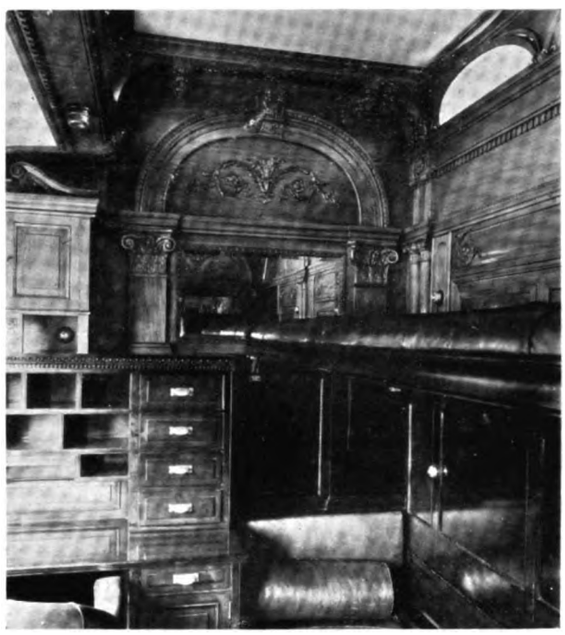
of ornamental glass and hinged for ventilation. The entrance to the carriage is effected by two side doors on the balcony, and two doors in the luggage compartment. A gangway plate in conjunction with a collapsible gate is provided for each end so as to form a connection between carriages in a train. Each compartment is fitted up with Stone's system of electric lighting; oil lamps, in addition, are also provided, as well as electric bell gear connected to the kitchen.

The framing and exterior woodwork is of teak, varnished in natural grain. Each window opening is provided with three independent frames, a louvre frame, glass frame, and gauze dust-proof frame. The glass frame is provided with spring balancers. This arrangement of window frames is an innovation, and one which will be greatly appreciated in South Africa owing to the prevalent dust-storms. A cold storage locker, lined with zinc, is fitted on one side of the underframe, and a refrigerator with a trap door opening into the corridor on the other. A water tank having a capacity of 96 gallons is secured to the underframe, having a pump connection to tanks in the roof over the kitchen lavatory and bathroom, giving a total capacity of 361 gallons.

The underframe is composed of channel steel and is mounted on two four-wheel bogies of the latest South African type. The draw and buffing gear is of the central radiating type. The brake gear is of the standard vacuum type with a controlling valve on the balcony.



Specimen Views of Interiors of Saloon Car—Rhodesia Railway.

The other type of carriage is a saloon intended for the use of the Administrator of Rhodesia, Sir W. H. Milton, K.C.M.G., in his journeyings throughout the country. The length over the corner pillars is 46 ft. 6 in., and the length over platforms, 54 ft. 4 in., and the distance between bogie centres, 39 ft. 7 in. The other dimensions are the same as those of the car previously described. The carriage is divided into six compartments, and many of the arrangements are the same as in the previous case. In the living room,

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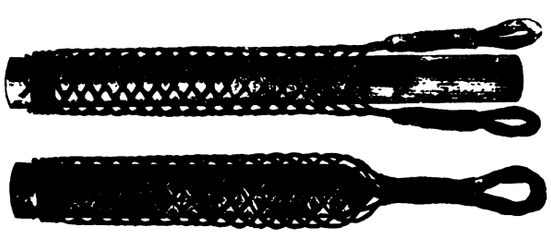
however, the woodwork is of fumed Spanish mahogany in the lower part, with pale mahogany above. At one end is a handsomely carved sideboard. There is one instead of two bedrooms. The back of the couch is hinged, so that it can be lifted up to form an upper berth. The upholstery is in dark blue morocco. A wardrobe and a writing desk are provided in addition to the fittings mentioned in the previous case. A secretary's room adjoins. The general finish is in light and dark fumed oak, and two berths are fitted. There is ample writing desk accommodation. The special feature of the lavatory is what is called a needle shower bath, which it appears is much appreciated in South Africa. The luggage room also serves as the servants' bedroom, and is fitted with two berths. The fittings in the kitchen and on the platform are similar to those previously described, and the general features of the car are covered by what has been said of those of the other saloon.

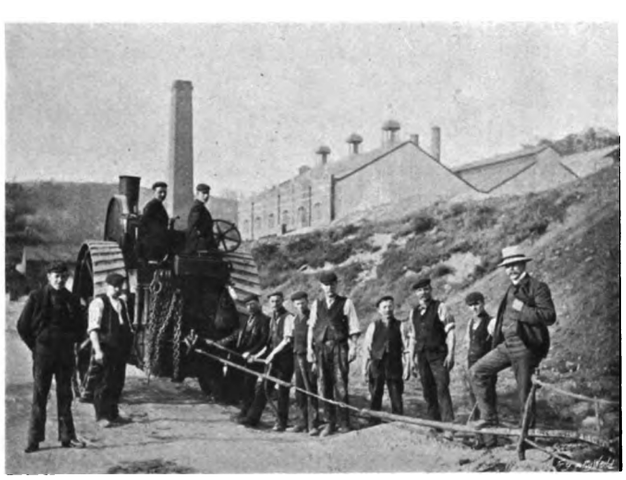
A USEFUL ATTACHMENT FOR DRAWING CABLES.

A novel method of drawing cables at Sheffield is brought to our notice by Mr. Rowland Hibbins of the Corporation Electric Supply Department. The photograph depicts a feeder cable being drawn with a Felten and Guilleaume cable grip attached to a powerful traction engine. Most engineers will at once appreciate the enormous strain upon the grip, which holds on with such tenacity that either the rope or the



cable will have to give way before a failure in drawing can occur, as on account of the construction of the grip, the greater the pull, the more securely it holds.

Mr. Hibbins hopes by giving publicity to the great utility of the grip that other engineers of Corporations



and supply companies may share with him in the benefit he has derived from its use, and although he has put the grips to the severest strains they have given satisfaction, and come out of the ordeal with great credit to the manufacturers, Messrs. W. F. Dennis and Company, 49, Queen Victoria Street, E.C.

REAR LIGHTS ON VEHICLES.

We have received a copy of a letter which Mr. H. England, general manager of the Wakefield and District Light Railways Company, and president of the Association of Tramway and Light Railway Officials, has addressed to all the tramway and light railway managers in the country, respecting the necessity for an enactment to compel all vehicles to carry rear lights before sunrise and after sunset. Mr. England considers it absolutely necessary to the safety of the public and to enable tramway and light railway managers to conduct their business in a proper manner, that this should be made compulsory — a proposal which tramway officials will, we are sure, heartily support.

Mr. England remarks that several collisions have recently occurred which were entirely due to the fact that ordinary vehicles using the road do not display rear lights. "I know the same trouble," he writes, "is experienced on other tramway and light railway systems, and I feel so strongly that some steps should be taken to bring about an alteration in the present law, so that all vehicles may be compelled to carry rear lights, that I ventured to write and ask whether you have had any accidents due to this cause, and whether you would be willing to take part in a movement to attempt to bring about an alteration in the law governing this matter. I believe the various county boroughs and the county authorities have power to make bye-laws by which all vehicles within the areas they control would be compelled to display rear lights after sunset, but, as a matter of fact, in the places where such a bye-law is most necessary it is not in force. This question should not be left to the discretion of the local authorities, because by so doing, a bye-law may be made and enforced by one local authority, whilst in a far more dangerous neighbourhood, with badly lighted streets, no action will be taken. As tramways are now being carried further into the suburbs and along country roads, the need for an enactment by which the men in charge of vehicles may be forced to safeguard themselves and other persons using the roads against accidents, is becoming more seriously felt. It seems absurd that tramcars and motor-cars—by far the fastest vehicles on the roads—should be required to display rear lights, and the crawling wagon, with the driver often asleep or tipsy, should be exempt. Tramcars are so brilliantly lighted that he would indeed be a blind man who ran into one from behind, and motor-cars are so fast that it would be impossible for other road vehicles to overtake them. Still both tramcars and motor-cars must carry rear lights. The Board of Trade has very properly given permission for higher speeds to be run on most of the tramways in this country, and although it is possible to safely speed up the cars during daylight, as soon as darkness descends it is courting disaster to run to the same schedule, owing to the fact that a wagon may suddenly loom out of the darkness ahead, and before the motorman has time to stop his car the collision occurs. The public cry for quick transit, and unless we, as tramway officials, are prepared to give them what they want, the financial aspect of our undertakings must suffer. The request that all vehicles should be compelled to display rear lights is not an unreasonable one, and I hope I shall succeed in obtaining your support and assistance in this matter."

Tramway and light railway managers are requested to fill in a form which accompanies this letter asking: (1) Whether their tramways are laid in a borough or county, or both; (2) whether they have had collisions attributable to the absence of rear lights on vehicles; (3) whether they think it desirable that all vehicles should carry rear lights; (4) whether they are willing to assist in bringing this question before the Government.

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PEEBLES (TYPE S) TRAMWAY MOTORS AND CONTROLLERS.

The Peebles (type S) tramway motor, manufactured by Messrs. Bruce Peebles, and Company, Edinburgh, is a good example of the more powerful class of motor used on British tramway systems, being adapted for

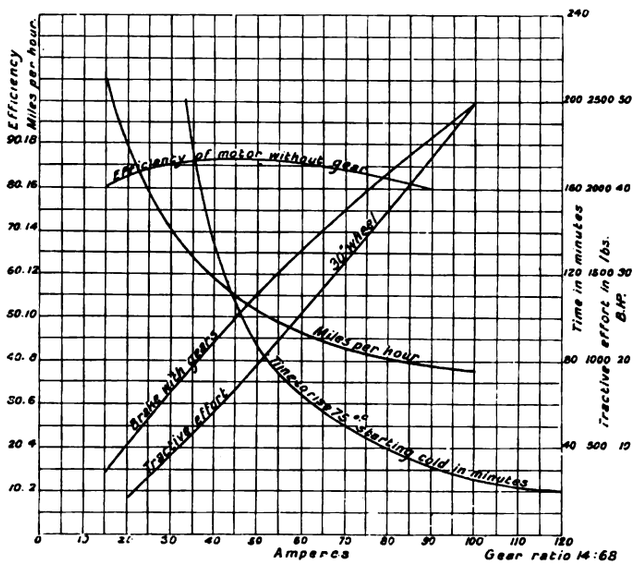
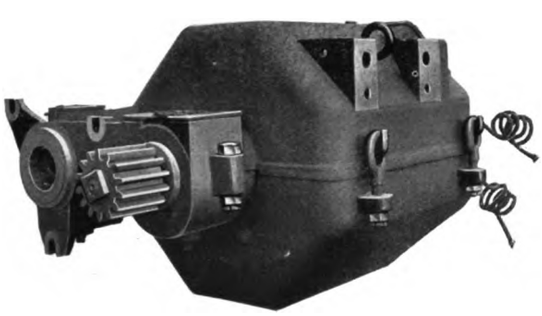


Fig. 1.—Performance Curves of Bruce-Peebles Motor.

use either with medium-weight cars making fast schedules over hilly routes, or for heavy cars on easier systems. It will be seen from the curves (Fig. 1) that, on a one hour's rating, tested stationary and totally enclosed, the output of the motor is 35 H.P. measured at the car axle, the efficiency with gears at this load being about 85 per cent. Of course, the rating of the tramway motor by horse-power in this manner does not give complete information with regard to its service capacity, as the loads are continually fluctuating through such wide limits, but an examination of the



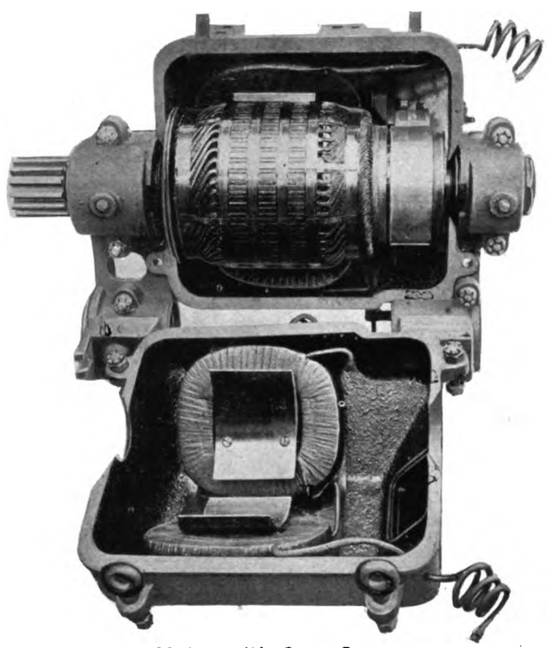
View of Motor Case.

curves shows excellent characteristics in the motor. The efficiency, which reaches 85·5 per cent. as a maximum is maintained very high over an unusually long range.

In external form, and in the arrangements for suspension, etc., the Peebles motor is in conformity with the best modern practice, such as has now been practically standardised. The frame is of cast dynamo steel of the best quality, of roughly octagonal form, divided horizontally, the upper half of the frame carrying the journals both for the motor bearings and the car axle bearings. Large doors both in the upper and lower half provide access to the commutator and brush gear. By loosening one or two bolts the lower half of the field frame may be swung away from the upper half, and the motor is thus completely opened out for inspection over the pits in the car shed. It is, further, a simple matter to remove the lower half-field, and also the armature in its bearings if required.

Each of the motor bearing journals is provided with two lubricant boxes fitted with spring lids and gaskets, and thus either oil or grease can be used, or both. The motor bearings are of gun metal, each $7\frac{1}{2}$ in. in length by $3\frac{3}{4}$ in. in diameter, the maximum diameter of the motor shaft being $4\frac{1}{2}$ in. The axle bearings are babbited, and are 4 in. by $7\frac{1}{2}$ in. in standard motors, but the axle boxes are so arranged that a different size of shaft can readily be taken.

The motor bearings are made of gun metal on account of the desirability of avoiding wear in these bearings, so



Motor with Case Open.

as to prevent any liability of the armature touching the fields. The bearing surface is very long and the lubrication has been skilfully arranged; carefully designed oil-thrower rings on the shaft within the bearings prevent any possibility of oil getting on to the armature of the motor and injuring the insulation.

The leads are as usual brought out independently through insulating bushings from the lower halves of the field, in order to avoid trouble when opening up the motor.

Motor Armature.

The motor has inwardly projecting solid poles fitted with long extended pole shoes of a form which absolutely prevents sparking, except at the very heaviest overloads. The field coils are of copper of ample section, carefully wound, taped and varnished, baked several times and insulated from the frame with presspahn and mica. The weight is kept off the pole tips by the use of substantial cast-iron clamps. It will be noticed that laminated poles are not used. Messrs. Bruce Peebles and Company have never believed in the lamination

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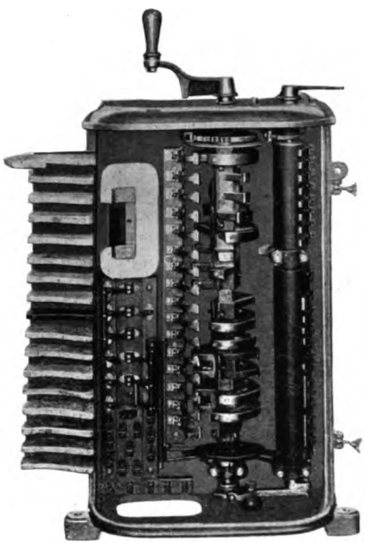
of field circuits for continuous current machines, regarding this practice as a survival from the days when continuous current armatures were made with a small number of teeth, and large slots, and when in consequence the eddy currents caused in a solid pole face were quite considerable. With, however, such armatures as are used with the Peebles motor, having a very large number of slots, these eddy currents are reduced to a negligible figure. From a commercial point of view the use of solid poles has the advantage of making a somewhat more liberal design of the other portions of the motor possible and thus improving the output, commutation, and efficiency of the motor. The armature has 49 slots, and there are 147 segments in the commutator. The commutator is of ample depth, and allows about ¾ in. reduction in diameter; owing to the special form of pole pieces which is adopted with the solid poles, the sparking is reduced to a minimum, which greatly prolongs the life of the commutator



Controller, Open.

Controller Cover.

The armature core plates are clamped between end plates of the form usual in traction motors, and the windings are held in place by four bands, insulated from the core and windings by mica. Additional bands over the ends of the conductors, both at the commutator and at the other end of the armature, prevent spreading of the coils should the armature attain an undue speed. The armature has further been designed with very small fly-wheel action, thus reducing the amount of energy dissipated at every stop, and reducing the amount again stored up in the armature at starting.

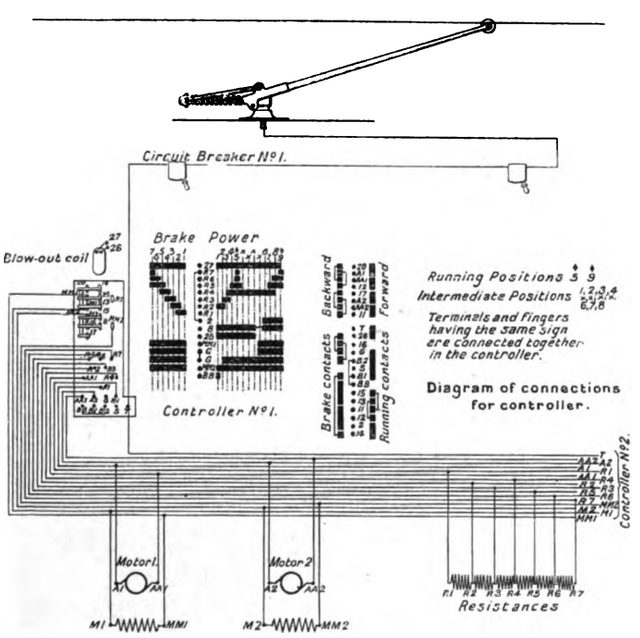


Fig. 2.—Diagram of Controller Connections.

The brushes, which are of carbon, slide off machined surfaces in substantial box type brush holders, and are pressed down on the commutator by suitable triggers. The brushes are very easily removed, the type of brush holder being the simplest possible.

The weight of the motor complete, together with bearings, brasses, and pinion gear and gear case is approximately one ton. Any type of suspension can be arranged for if required; as a general rule, however, the "nose" type of suspension is found most satisfactory.

The controller used is of the magnetic blow-out type, and has in all three drums, namely, a main drum, at which the breaking of the circuit in service always takes place; a reversing drum; and a further small drum actuated by a rack from the main drum, the position of the contacts on which determine whether the motors are connected for braking or running. The controller has five series and four parallel running positions, besides four positions intermediate between the first parallel and the last series notch, and there are also seven braking positions for use with ordinary service rheostatic braking, or with an electro-magnetic brake.

The diagram of connections (Fig. 2) will clearly indicate the connections of the controller, which can readily be traced out, remembering the fact that all contacts, fingers and leads having the same symbol are permanently connected in the controller. A large blow-out coil is fitted to reduce sparking at the contacts, and a number of breaks in series are arranged for when a heavy current has to be broken; for instance, in turning from the first series notch to the "off" position, the current is broken at six points in series under the influence of the magnetic blow-out. Provision is made for cutting out either motor should it be injured, and with one motor cut out it is impossible to move the main handle of the controller beyond the last series position with no resistance in circuit.

TRAMWAY OBSTRUCTION.

Cases occur with irritating frequency in which tramway companies have been compelled to take action against tradesmen who permit their vans to load and unload while standing on the tramways and refusing to move them until their business has been completed. A case of this description came before the Worcester Police Court recently, in which a local grocer was summoned at the instance of the Worcester Electric Traction Company, Limited. The defendant appears to have acted with peculiar obstinacy. When remonstrated with, he not only refused to move his van in order to allow a car to pass, but when the horse (apparently more amenable to reason than its master) moved across the street of its own accord, he had the temerity to turn it back again in front of the tramcar, thus aggravating his offence. Altogether the car was delayed some five or six minutes. To illustrate the law as to the relative rights of a tramcar and a tradesman, a judgment by the Master of the Rolls in a Brighton case was read. The Master said, "The primary object of the street is for the free passage of the public, and anything that may impede that free passage is a nuisance. If a business man requires for the purpose of loading and unloading so many more carriages than can be accommodated upon his premises, he must enlarge his premises or remove his business to some more convenient spot. The private right to carry on business must yield to the public user of the highway." The defendant claimed that he had a right to keep his cart there as long as it was necessary for his business, but the Bench found he had obstructed the highway and imposed a fine of 10s. and 18s. 6d. costs. The tramway company originally sought to obtain convictions both under the Highways Act of 1835 and the Light Railways Act of 1896, but as the Bench convicted the defendant for obstructing the highway, they withdrew the latter charge, pointing out that it was an indictable offence needing to be sent to the Quarter Sessions; the company, however, merely wished to make it known what were the rights of tramway companies and of citizens.

NEWCASTLE TRAMWAY MANAGEMENT.—A large number of applications for the position of manager of the Newcastle Corporation Tramways have been received, and a sub-committee has been appointed to consider them.

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ANALYSES OF TRAMWAY REPORTS.

ABERDEEN CORPORATION TRAMWAYS.

YEAR ENDING MAY 31, 1904.

Electric traction inaugurated, December, 1899.

	£
Borrowing powers	
Loans outstanding	301,176
Sinking Fund	7,662
Depreciation, Renewal, and Reserve Funds	24,378

CAPITAL EXPENDITURE.

	£	s.	d.
Permanent way	191,792	11	6
Electrical equipment of line	55,805	16	8
Ground and buildings	26,216	12	2
Cars	46,507	14	2
Sundry plant	3,296	18	4
Office furniture	148	5	8
Preliminary and Parliamentary expenses	7,017	5	6
Total	£330,785	4	0

Capital expenditure per mile of single track, £12,972.

REVENUE ACCOUNT.

INCOME.

	£	s.	d.	Av. per Car Mile d.
Traffic	63,246	2	8	11·00
Advertisements	552	0	0	·09
Rents	259	5	0	·045
Miscellaneous	14	2	1	·003
	£64,071	9	9	11·14

EXPENDITURE.

Power Expenses.

	£	s.	d.	£	s.	d.	d.	d.
Cost of 104,243 units at 1·85d. per unit ..	803	10	10					
Cost of 1,421,465 units at 1·65d. per unit ..	9,772	11	6					
	10,576	2	4					
Less rebate from last year	949	12	10					
				9,626	9	6		1·675

Traffic Expenses.

Superintendent's salary and inspectors' wages	886	3	4				·154	
Wages of motormen, conductors, etc.	12,078	7	7				2·098	
Uniforms	811	3	7				·150	
Cleaning and oiling cars	1,900	7	7				·330	
Cleaning, salting, and sanding track	322	5	10				·057	
Tickets	268	3	5				·047	
Licenses	81	7	6				·014	
Fuel, light, and water for depôts	390	1	2				·067	
Provender for depôt horses	72	11	7				·012	
				16,810	11	7		2·929

General Expenses.

Salaries & office expenses	641	15	5				·112	
Contribution to Feu Fund	100	0	0				·011	
Rates and taxes	1,176	16	6				·205	
Rents	374	0	1				·065	
Feu duties	126	11	7				·022	
Printing and stationery	265	16	3				·046	
Mileage rate to municipal department	177	5	8				·031	
Fire insurance	71	3	9				·012	
Accident insurance ..	600	13	10				·105	
Travelling expenses ..	149	0	0				·026	
Miscellaneous	256	15	6				·045	
				3,939	18	7		·680

Repairs.

Permanent way	2,332	4	9				·406	
Electrical equipment ..	914	15	11				·159	
Buildings	147	17	7				·026	
Cars	3,193	5	5				·556	
Sundry plant	89	10	0				·015	
				6,677	13	8		1·162
Total				37,054	13	4		6·446
Balance carried to Net Revenue Account				27,016	16	5		4·694
				64,071	9	9		11·14

NET REVENUE ACCOUNT.

	£	s.	d.	£	s.	d.
Balance from Revenue Account ..				27,016	16	5
Deduct—						
Interest	9,499	13	11			
Sinking Fund	2,396	8	10			
Preliminary and Parliamentary expenses	889	7	6			
Depreciation and renewal	14,231	6	2			
				27,016	16	5

TRAFFIC STATISTICS.

Population served	157,000
Length of line operated (single)	25½ mls.
Passengers carried	15,538,167
Car mileage	1,379,273
Passengers carried per car mile	11·26
Average fare per passenger	·98d.
Operating expenses per passenger	·57d.
Percentage of operating expenses to total receipts ..	57·75
Board of Trade units	1,525,708
Cost per Board of Trade unit	1·66d.
Board of Trade units per car mile	1·11d.

BOURNEMOUTH CORPORATION TRAMWAYS.

YEAR ENDING MARCH 31, 1904.

Electric traction inaugurated, July, 1902.

	£
Borrowing powers	274,769
Loans outstanding	291,921
Sinking Fund	8,057
Depreciation, Renewal, and Reserve Funds	

CAPITAL EXPENDITURE.

	£
Capital expenditure	261,618

Capital expenditure per mile of single track owned, £14,375.

REVENUE ACCOUNT.

INCOME.

	£	s.	d.	Av. per Car Mile d.
Traffic revenue	52,445	4	3	12·31
Other revenue	953	10	0	·21
	£53,398	14	3	12·54

EXPENDITURE.

Power Expenses.

	£	s.	d.	d.	d.
Cost of power for all purposes, less receipts from street lighting	6,319	9	1		1·49

Traffic Expenses.

	£	s.	d.				
Salaries and wages ..	10,376	12	6			2·44	
Car oiling and cleaning	1,683	7	11			·39	
Sanding track	220	17	1			·05	
Fuel, light, and water ..	294	4	7			·07	
Ticket check	395	19	7			·09	
Uniforms	328	6	7			·08	
Car licenses	35	1	3			·01	
				13,334	9	6	3·13

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General Expenses.

	£ s. d.	£ s. d.	
Manager's disbursements and compensation	734 12 8		·17
Rent, rates, and taxes ..	1,079 13 8		·25
Printing and stationery ..	248 10 9		·06
Insurance	76 9 7		·02
Miscellaneous	67 4 0		·02
		2,206 10 8	·52

Repairs.

	£ s. d.	£ s. d.	
Overhead system ..	1,500 8 0		·35
Conduit system	2,174 9 10		·51
General	3,742 11 1		·88
		7,417 8 11	1·74
Total		29,277 18 2	6·88
Balance to Net Revenue Account ..		24,120 16 1	5·66
		£53,398 14 3	12·54

NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account ..		24,120 16 1
Deduct—		
Interest	9,051 1 9	
Sinking Fund	7,335 12 11	
		16,386 14 8
		£7,734 1 5

TRAFFIC STATISTICS.

Population served	60,000
Length of line operated (single)	18 ms. 16 chs
Passengers carried	9,363,985
Car mileage	1,022,164
Passengers carried per car mile	9·16
Average fare per passenger	1·34d.
Operating expenses per passenger	·75d.
Percentage of operating expenses to total receipts ..	54·82
Board of Trade units (traction)	1,412,723
Cost per Board of Trade unit	
Board of Trade units per car mile	1·38

BRIGHTON CORPORATION TRAMWAYS.

YEAR TO MARCH 31, 1904.

Electric traction inaugurated, November, 1901.

	£ s. d.
Borrowing powers	276,170 0 0
Loans outstanding	212,137 5 1
Sinking Funds	5,804 0 11
Reserve Fund	1,083 13 2

CAPITAL EXPENDITURE.

	£ s. d.
Land	3,863 18 0
Brewery property	25,819 16 9
Car sheds	26,036 14 2
Permanent way	127,173 17 4
Widening streets	382 19 5
Electrical equipment of line	17,430 4 5
Cars	27,365 12 11
Machinery and plant	5,043 1 3
General expenses	2,443 16 9
Parliamentary expenses	5,400 0 0
Miscellaneous	1,851 3 0
Total	*£242,811 4 0

* This expenditure includes lines under construction, while mileage given is that operated.

REVENUE ACCOUNT.

INCOME.

	£ s. d.	Av. per Car Mile d.
Traffic revenue	46,039 17 5	9·60
Other revenue	224 6 5	·04
	£46,264 3 10	9·64

EXPENDITURE.

Power Expenses.

	£ s. d.	d.	d.
Electrical energy	11,093 13 6		2·31

Traffic Expenses.

	£ s. d.	£ s. d.	
Superintendence & wages	14,489 11 9		3·02
Miscellaneous	2,333 10 6		·49
		16,823 2 3	3·51

General Expenses.

	£ s. d.	£ s. d.	
Salaries and wages ..	1,871 1 5		·39
Rates and taxes	223 13 4		·04
Printing and stationery ..	394 10 10		·08
Insurances	672 0 9		·14
Law charges	74 1 3		·02
Parliamentary expenses	108 8 7		·02
Miscellaneous	488 5 7		·11
		3,832 1 9	·80

Repairs.

	£ s. d.	£ s. d.	
Permanent way	2,504 11 6		·52
Electrical equipment ..	486 4 5		·10
Buildings	362 2 8		·08
Machinery and plant ..	201 13 11		·04
Cars	4,914 19 6		1·02
		8,469 12 0	1·76
Total		40,218 9 6	8·38
Balance carried to Net Revenue Account		6,045 14 4	1·26
		£46,264 3 10	9·64

NET REVENUE ACCOUNT.

	£ s. d.	£ s d.
Balance from Revenue Account ..		6,045 14 4
Deduct—		
Interest	7,199 10 9	
Sinking Fund	3,487 16 8	
Income Tax	137 3 3	
		10,824 10 8
Balance, being deficit		£4,778 16 4

TRAFFIC STATISTICS.

Population served	123,500
Length of line operated (single)	13 m. 44 ch.
Passengers carried	10,999,046
Car mileage	1,151,471
Passengers carried per car mile	9·55
Average fare per passenger	1·00d.
Operating expenses per passenger	·88d.
Percentage of operating expenses to total receipts ..	86·92
Board of Trade units	1,774,988
Cost per Board of Trade unit	1½d.
Board of Trade units per car mile	1·54

CHESTERFIELD CORPORATION TRAMWAYS.

Chesterfield Corporation Tramways were inspected on behalf of the Board of Trade on Tuesday, December 20, and regular service was begun on the following day. The Corporation obtained an Act in last session authorising the tramways, and they lost no time in beginning the work. Contracts were let in July, and the construction of 3½ miles of route, the car shed, the extension of the generating plant, and the cars are now practically completed. The whole of the work has been carried out under the personal direction of Mr. R. L. Acland, borough electrical engineer and tramway manager, who has been responsible for the designs and specifications. The British Insulated and Helsby Cables, Limited, have constructed the track and overhead work, and they have supplied and laid the feeders. British standard rails of No. 2 section have been used. The British Westinghouse Electric Company have supplied all of the four generators now in the station, the last machine put in being a 400-KW. multipolar generator. All of the generators can be used either on the lighting or traction load. The engines are by Bellis and Morcom, Limited, and the boilers by Babcock and Wilcox. The cars are of the top-deck type, with Brush stairways and folding step. Both car-bodies and trucks, the latter of the Conaty radial type, were constructed by the Brush Company, but the motors and controllers have been supplied by the Westinghouse Company. Standard patterns have, as far as possible, been used throughout, and the result is a thoroughly satisfactory installation which cannot fail to prove an immense advantage to the borough.

THE GOLDSCHMIDT-THERMIT COMPANY, of 27, Martin's Lane, Cannon Street, E.C., in addition to having received the Grand Prix, have been asked by the United States Government to present their entire exhibit at the St. Louis Exhibition to the National Museum at Washington, to be placed on exhibition there. Although the value of the materials is considerable, the Company have decided to comply with the Government's wish.

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LONDON COUNTY COUNCIL TRAMWAY MATTERS.

Standardisation of Rolling Stock, etc.

At a meeting of the London County Council on December 6, the Highways Committee presented a report on the above subject. They stated that in view of the great extent of the Council's electric tramways undertaking they considered it was desirable that, so far as possible, the various parts and details of the rolling stock and plant should be standardised. Standard samples and patterns should be prepared for all the various parts of the rolling stock, etc. It was particularly important that the Council should have a full range of specifications, drawings, patterns, etc , covering every detail of tramway rolling stock. By possessing its own patterns the Council would be enabled to have castings supplied direct from the foundry and finished in its own workshops. The Committee estimated that the cost of preparing the drawings, patterns, and other data necessary would be about £350. They recommended that a special maintenance estimate of £350 be approved.

The recommendation was adopted by the Council without discussion.

Economical Engines.

At a meeting of the Council on December 13, the Highways Committee, in a report, referred to contracts, amounting to £25,964 and £46,626, with Dick, Kerr and Company, Limited, for continuous-current plant and three-phase plant respectively. Under the terms of the specifications for the engines supplied under each contract the contractors were entitled to a bonus of £300 a pound for every pound or fraction of a pound by which the steam consumption of each engine fell short of 24 lb. per kw. hour. Tests had been made, with the result that the actual consumption was found to be 22·35 lb. per kw. hour at full load. This corresponded to a reduction of 1·65 lb. per kw. hour on the guarantee, and the contractors were accordingly entitled to a bonus of £495 on each of the four engines, making a total of £1,980. There was an unexpended balance of nearly £950 on the estimates for this and other plant, and this balance could be utilised to pay part of the bonus. The Committee, therefore, proposed that a supplemental capital estimate of £1,050 be approved, and that expenditure on capital account of £2,000 be sanctioned in addition to the sums authorised under the contracts.

Additional Roof Covers.

The Committee referred to the provision of roof covers for 61 of their electric cars. Fifty-one of these roof covers had been ordered from Messrs. Milnes, Voss, and Company, Birkenhead, and the remaining 10 had been put in hand at the Council's own car works. Some of the covers had already been fixed, and were in use. The results of working the cars with roof covers had been very satisfactory, the traffic receipts having been considerably more on these cars than on the ordinary cars on the same routes. The cost, owing to certain improvements, would be increased, and the probable expenditure in connection with the 61 roof covers would amount to about £5,560, or £500 in excess of the estimate.

The Highways Committee, in a special report, referring to the satisfactory results of the experiments with roof covers, stated their opinion that 100 additional cars should be fitted with covers as soon as possible. They proposed that the work should be executed by the Council's tramway staff. The type of cover proposed was the "Magrini," patented by Messrs. Milnes, Voss, and Company, and a royalty of £4 10s. would have to be paid to that firm for every such roof cover made by the Council. The probable cost of the 100 roof covers, including royalties, would not exceed £8,500. The Committee recommended approval of an estimate of £8,500 for the purpose.

Jew's Row Car Shed.

The Committee also reported that they had had under consideration the question of the reconstruction of the lines in Battersea and Wandsworth, which were transferred to the Council from the South London Tramways Company, and the construction of the other tramways in Garratt Lane, etc. In connection with this matter it would be necessary to provide for the requisite car shed and sub-station accommodation. It was proposed that sub-stations should be erected on sites now belonging to the Council in Queen's Road, Battersea, and East Hill, Wandsworth. As regarded car sheds, it was proposed to rebuild the Council's existing car sheds at Jew's Row, Wandsworth. The site was, however, limited in size, and statutory authority had been obtained under the Council's Tramways Act of 1904, for the acquisition of additional property. The estimated cost of the property was about £5,500, and the Committee recommended that an estimate to that amount be approved.

Expensive Street Widenings for Tramways.

The Improvements Committee presented a report in regard to five street widenings for the purpose of constructing tramways, which were authorised by the Council's Tramways and Improvements Act, 1904. The respective costs of these widenings were: For the Lordship Lane to Forest Hill tramway, £21,500; Lewisham High Road to Forest Hill tramway, £104,000; New Cross Road to Lee Green tramway, £154,000; Catford to Greenwich tramway, £26,100; and Beresford Square to the county boundary at Woolwich tramway, £14,100; total, £320,000. The Committee stated that it was very desirable, in order that the expenditure might not be unduly increased, that these improvements should be undertaken and completed as early as possible. The local authorities concerned were required by statute to contribute one-third of the net cost, and another third would be charged to the tramways account. The total net amount, after deducting recoupment, was £314,500. The Committee recommended approval of the five estimates.

The Finance Committee, reporting on the subject, stated that in July, 1903, they had reported on the financial bearings of tramways proposed by the bill passed in the session of 1904. They had stated at that time that on the basis of a surplus of receipts over expenses of 6d. per car mile, and assuming that the traffic would be sufficient to maintain the frequent service estimated, there appeared every probability that the proposed tramways would be self-supporting from the first. In one case—that of the tramway from Catford to Rushey Green, which consisted of the re-construction of an existing horse line—the Highways Committee did not propose to re-construct the whole of it at present, so that the cost for street improvements for this part would be £5,800 instead of £26,100. The cost of the five tramways was estimated at £386,500, so that the total capital outlay was £706,500, but upwards of £100,000 of this was contributable by the local authorities. As regarded the probable financial results of the tramways, there would be a probable annual deficit of £18,181, which would decrease as the debt was paid off. The difference between the revised estimates and the results of those of 1903 was accounted for in two ways. First, the earlier estimates were based on an estimated surplus of working of 6d. per car mile, whereas the present estimates, prepared after experience of actual running by electric traction, allowed for a surplus of 3d., and in one case of 4d., per car mile, after allowing 1d. per car mile for renewals. Second, the revised estimates were based on services for four, five, or six minutes, whereas the earlier estimates were for services for two, three, or four minutes. The Finance Committee realised the fact that the Council was committed to these tramways, both by its own resolutions and the proceedings before Parliament, and to carry them out as speedily as possible.

The first two proposals of the Highways Committee were adopted without discussion, but the last two, and that by the Improvements Committee, in accordance with the standing orders, stood over for a week.

Street Widenings for Authorised Tramways.

At the meeting of the Council on December 20, the Highways Committee submitted a special report bearing upon the report adjourned from the previous week of the Improvements Committee, in reference to street widenings to be carried out in connection with the construction of five authorised tramways in the south-east of London. The Highways Committee now stated that each of the lines was promoted owing to the pressing demand for improved travelling facilities in the districts affected. During the completion of the widenings the charge falling upon the tramways account would be comparatively small. The Finance Committee estimates were based upon the traffic that would be carried at the present time, while the Highways Committee were confident that by the time the lines were opened the traffic demands would have greatly increased. There would, moreover, probably be a very large amount of induced traffic on the present system. The Committee were strongly of opinion that the proposal should be proceeded with as soon as the street widenings were completed.

Greenwich Generating Station.

The Committee pointed out that it was necessary to arrange for a temporary end screen or wall, to be built at one end of the first portion of the Greenwich station, so as to enclose the building pending the erection of the second portion. It was proposed that the end screen should be constructed of corrugated iron on timber framing, and the cost would probably not exceed £3,230. In view of the urgency of the work, they proposed that tenders should be invited at once from a few selected firms, and should be dealt with by the Committee during the Christmas vacation.

The Committee had considered tenders sent in by 49 firms for the supply, delivery and erection of seven cast-iron water tanks required for the first portion of the Greenwich station. The tenders ranged from £1,174 up to £2,847. The Committee were of opinion that the lowest, viz., that of Messrs. S. Russell and Sons, Leicester, amounting to £1,174, should be accepted.

The Proposed New Bridge at Charing Cross.

A joint report was submitted by the Bridges and Improvements Committees upon a reference from the Council of July 12 last, asking them to report, in view of the necessity of providing additional traffic facilities and of linking up the northern and southern tramways, whether the South Eastern and Chatham Railway Company were contemplating the rebuilding of Charing Cross Station and the widening of Hungerford Bridge; and whether the Council should submit to Parliament a

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scheme for the acquisition of the railway station and the bridge, providing the railway company with a site for a new terminus station on the Waterloo side of the river, and erecting for general traffic a new road bridge of sufficient width to take a double line of tramway. The Committees stated that they were advised that the cost of acquiring a site for a railway station on the south side of the river would be very great, the compensation for removal from the present station would amount to a large sum, and a new bridge would be required. The railway company had been consulted, and had replied that they were contemplating the widening of Hungerford Bridge, as authorised by their Act of 1900, and also an enlargement of Charing Cross Station, but they were not contemplating rebuilding that station. The company were unable to see how a scheme for extending the benefit of Charing Cross Station to a greater number of passengers could furnish any justification for the County Council's proposal to deprive them of the use of it. In view of the very large expense involved, and also having regard to the attitude of the company, the two Committees felt that they had no alternative but to advise the Council for the present not to give further consideration to the matter, and they recommended that the reference to them be discharged.

WORKS COMMITTEE'S ECONOMIES.

In reference to a report by the Works Committee for the half-year ended September 30 last, upon work carried out by them, the Highways Committee stated that they had received an account for the construction of the foundations and the two chimneys for the Greenwich generating station. The quality of the work was in every respect satisfactory, while the cost was £24,472, or 16·9 per cent. below the value certified by the architect. This sum was nearly £7,000 less than the amount voted by the Council for the work.

On the reception of the report of the Highways Committee, Mr. J. A. BAKER, chairman of the Committee, in answer to questions, said that arrangements were in progress to run an experimental covered car somewhat lower than those on the Greenwich line, which might be placed on the Tooting line, but the Highways Committee would consider the desirability of approaching the railway companies and asking them to heighten the bridges on the route in question.

The various reports were adopted, except that dealing with the Charing Cross bridge scheme, which was postponed.

The Council adjourned over the Christmas recess.

NEW YORK SUBWAY AND LESSONS FOR LONDON.

REPORT BY MR. J. ALLEN BAKER.

Mr. J. Allen Baker, chairman of the Highways Committee of London County Council, who went to New York to represent the Council at the formal opening of the New York Rapid Transit Subway, has presented a long report which has now been printed and published. The opening ceremony was to have taken place on September 15 last, but it was delayed owing to strikes until October 27, and Mr. Baker was unable to remain in America till the later date. He was, however, afforded all possible information by Mr. W. B. Parsons, the chief engineer of the New York Board of Rapid Transit Commissioners, and was conveyed in a special train over the lines, while every opportunity was given him for detailed personal inspection. The result is a full illustrated description of the undertaking alike from the engineering, traffic, and public benefit points of view. The photographic illustrations are of much interest, and give a capital idea of the work. The ground covered by the report is very similar to that gone over in a description of the subway which appeared in our issue of November 10 last. In conclusion Mr. Baker draws some lessons for London, in which he says:

The statesmanlike and able way in which the New York Rapid Transit Board have sought a solution of the street traffic problem in their city is, I think, suggestive of what should be undertaken for London, if the same problem which is equally pressing here is to be solved.

London may expand, is yearly expanding, in every direction to accommodate her ever increasing population, but with the growth outwards, there is also a corresponding congestion in the central and business districts, and large business blocks are constantly being erected in and near the city as the old leases fall in. We have detached systems of tramways, suburban train systems, deep level railways, and omnibuses, but no co-ordinated and harmonious plan that meets the needs of the county as a whole. Omibuses in other cities have had to succumb to the more comfortable and speedy electric street car. Deep level tubes are admittedly less comfortable, less convenient and more costly to construct and operate than the shallow subway, and I do not think that they are likely to be largely extended in London. The electrification of the District and Metropolitan Underground Railways, and the lines in connection therewith, constitutes, however, an important step in the co-ordination of London locomotion.

The real solution, I am persuaded, is to be found in the further electrification and extension of the London County Council Tramways, and in the construction of further subways under some of the streets in the more central parts to make east and west, as well as north and south, connections. The authorised tramway over Putney Bridge will soon be constructed, while lines from the south to Victoria will be constructed when the new Vauxhall Bridge is opened. It is hoped that powers to construct lines over Westminster and Blackfriars Bridges may be obtained in the next session of Parliament. The Council's new subway under Kingsway, which will bring the Northern tramways as far as the Strand, is now under construction. If the connections with the proposed lines along the Embankment and across Westminster and Blackfriars Bridges, are sanctioned by Parliament, north and south through connection will for the first time be attained by the tramways, which will be of the greatest value to the Council's system and of immense benefit to the travelling public.

Powers were obtained in the last session of Parliament for the construction of a line from the Council's conduit lines in Greenwich to the southern end of the Blackwall tunnel. The lines along East India Road pass the northern end of the tunnel, and it only remains to obtain authority for a line through the tunnel to make a further and most valuable north and south connection in the East end.

An east and west shallow subway from Hammersmith to the Bank, with connections with the present subway at the Strand, and with radiating lines under the City to the tramway termini on the north and east boundaries of that area, would be a most valuable, and probably profitable, scheme. Another subway from the tramway terminus at Victoria Station to the Marble Arch, under Grosvenor Place and Park Lane, connecting with a surface tramway from there along Edgware Road to join the Middlesex lines at Cricklewood, should be carried through. Another valuable surface electric conduit line would be along Tottenham Court Road, Charing Cross Road, and via Trafalgar Square and Parliament Street to Westminster Bridge. The extension of surface lines, wherever possible, in the west and north-western parts of London, having connections with the present systems and affording access by subway to the City, should be carried out at no distant date, and then the reproach that now attaches to London, as being one of the most badly served cities in the world, so far as transit facilities are concerned, would to a large extent be removed.

New York has shown us an example of what enlightened civic enterprise can accomplish. London has the opportunity, with its existing tramway systems and its first tramway subway under construction, to extend, connect, and build up a complete and uniform system for the whole of the county that will be a credit to the capital of the empire.

NOTE.—COMPARISONS BETWEEN THE NEW YORK AND THE GREENWICH POWER-STATIONS.

Although designed quite independently, there are several points of resemblance between the power-station for the New York Rapid Transit Subway and the one now being constructed by the Council at Greenwich.

In each case the engine room is constructed parallel with the boiler room, and the boilers, which are of the water-tube type, are all on one floor. There is a row of boilers on each side, with a central firing floor between. The boilers are in each case divided into groups of six, and each double set of six uses the same chimney. The New York station is half as large again as the one at Greenwich, and, in consequence, there are six chimneys, each 15 ft. diameter and 225 ft. high, as against four at Greenwich, with a diameter of 14 ft. and 250 ft. high.

In each case the economisers are placed on a floor above the boilers, with coal bunkers at the top, but at Greenwich the bunkers are subdivided much more than at New York, probably giving greater security in case of fire. In the basement of the boiler house, in each case, are the hot well tanks, the ash shoots, and the ash conveyors.

The type of engine adopted, both in New York and at Greenwich, is the same, namely, a combined vertical-horizontal compound engine, with the generator mounted on the shaft, between each engine. There is this difference, however, between the two schemes. In New York, the horizontal cylinder is the high pressure, and the vertical the low pressure, while at Greenwich the opposite arrangement has been adopted. The results obtained by the arrangement at Greenwich appear to be of distinct advantage, as the engines are more easily balanced, and a more effective and simple system of drainage is secured. Moreover, there are no "water-pockets" of any kind, which may, however, very possibly result from the arrangement of the New York station. The engines at Greenwich also are entirely enclosed, and forced lubrication will be used, which results in a very appreciable saving of oil.

There is a marked contrast between the arrangement of the steam piping in the two power houses. The New York arrangement appears to be complicated, while that at Greenwich, in addition to being simpler in character contains, moreover, provision for an easy and natural system of drainage.

The switch-gear is of the same general type, namely, that of electrically-operated remote-control oil-break switches; in each case the switch-gear is arranged on the long side of the engine room.

Owing to the configuration of the land at Greenwich, and the construction of the pier, the bringing in of coal, and the taking away of ashes will perhaps be simpler than in New York, although the scheme, generally, is the same.

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ANNOTATED LAW REPORTS.

(*Specially compiled for* THE TRAMWAY AND RAILWAY WORLD.

IN THE COURT OF APPEAL.

BEFORE THE MASTER OF THE ROLLS AND LORDS JUSTICES STIRLING AND MATHEW.

In the matter of an arbitration between the Manchester Carriage and Tramway Company, Limited, and the Swinton and Pendlebury Urban District Council.

This appeal was brought from a judgment of Mr. Justice Channell upon a special case that had been stated by the late Sir Frederick Bramwell on an arbitration between the Swinton and Pendlebury Urban District Council and the Manchester Carriage and Tramway Company, Limited. The Urban District Council were purchasing that part of the Manchester Carriage and Tramway Company's undertaking which was in their district, under the provisions of the well-known section 43 of the Tramways Act of 1870, and the question raised was whether under this section the Council were compelled to purchase certain of the company's works, consisting of two large depôts outside their district. These originally served as depôts for omnibus, cab, and fly traffic, but had been altered and enlarged by the company when they had been acquired by them. The Council desiring to purchase the tramway undertaking served the company with a notice to purchase, and Sir Frederick Bramwell was appointed referee by the Board of Trade. The Council contended that they were not bound to purchase the depôts which were outside their district, for even if they were suitable for tramway purposes, they were still outside their district. On the other hand, the company argued that if in fact the depôts were suitable for and used with the undertaking the Council were necessarily bound to purchase them. The question of law depended upon the construction that was to be put upon Section 43, which runs as follows: "Where the promoters of a tramway within a district are not the local authority, the local authority . . . . may . . . by notice in writing require such promoters to sell, and thereupon such promoters shall sell to them their undertaking, or so much of the same as is within their district, upon terms of paying the then value . . . . of the tramway, and all lands, buildings, works, materials, and plant of the promoters suitable to and used by them for the purposes of their undertaking within such district."

Obviously two constructions seemed possible, that of the Tramway Company and that of the Council as put before Sir Frederick Bramwell. After an inspection, Sir Frederick Bramwell found, as a fact, that one of the depôts was not suitable, but that the other was, and was also used with the undertaking. As will be seen by the judgment, this finding was ambiguous. He awarded in respect of the value of the latter depôt (exclusive of any allowance for past or future profits or allowance for compulsory purchase, but including the tramway lines thereon and the tramway lines leading thereto, the sum of £24,009). He also awarded a sum of £308 in respect of fixtures and fittings. In the special case the question left for the Court to decide was whether this sum was admissible or not. In the event of its not being admissible he awarded £24,000 in respect of the undertaking purchased within the district. On appeal Mr. Justice Channell decided in favour of the company that the item was admissible. The Council appealed. The Court reserved their decision, ultimately giving it, as will be seen by the judgment of the Master of the Rolls, in favour of the District Council.

The MASTER OF THE ROLLS said that the question had arisen under Section 43 of the Tramways Act of 1878, and, after reading the Section, stated that whilst the company existed the whole of the tramway was conducted under one management, and certain depôts were used by the company in connection with the tramways which were separated by some distance from the nearest boundary in the Council's district. One of the depôts had been found by the late Sir Frederick Bramwell to be unsuitable. With regard to the other he had, in the special case elaborately described the geographical portions and all the physical conditions of the depôt, and all the purposes for which it was used, and he had formulated his own opinion for the opinion of the Court. To bring this depôt within the meaning of the Section it was necessary that it should be suitable to and used by the company for the purposes of their undertaking within the district. It was not easy to ascertain whether in addition to the point of law as to the depôt being outside the district, it was intended to raise a further point of law that having regard to the special circumstances of the geographical situation and the user of the depôt it was not, and as a matter of law could not be held suitable to and used for the purposes of the undertaking within the district. Undoubtedly the District Council had desired to raise the point, and the arbitrator instead of confining the special case to the simple matter of the depôt being outside the district, had stated the whole of the facts as to the position of the depôt and the rights of use. It seemed to him that the arbitrator had meant that the depôt was in fact used with but not for the purposes of the undertaking, instead of used for the purposes of the undertaking. It seemed to him more probable that the arbitrator meant that this depôt was in fact used with but not for the purposes of the undertaking, but that he thought that the circumstances under which it was so used were sufficient in point of law to enable him to treat his finding as equivalent to a finding that it was used for the purposes of the undertaking, and that he desired to leave that point to the Court. The finding being ambiguous he was unable to say what had been found. It was therefore impossible under the circumstances to affirm that there was any obligation on the part of the Council to buy the depôt, the appeal was therefore allowed.

The other Lords Justices concurred.

It will be seen that this decision does not affirm the proposition that a depôt for instance, or lands, buildings, works, and materials outside the district, cannot be compulsorily acquired, which would place a very narrow construction upon Section 43 of the Tramway Act. All that it comes to is this: that the lands, buildings, works, etc., must both be suitable to and used by the vendor company for the purposes of their undertaking within the said district, if they happen to be situated in fact outside the district.

DAWSON V. THE GREAT NORTHERN AND CITY RAILWAY COMPANY.

By the same tribunal on December 9 a considered judgment was given in this case. The judgments are too long to be set out in full, but many of the points are of the utmost importance to undertakers under the Regulation of Railways Act, Section 41. The action originally came before the late Mr. Justice Wright and a jury on an award given in respect of structural damage and damage to stock-in-trade occasioned by the subsidence of freehold houses, 119 to 125 odd numbers, City Road, and 1 to 5 odd numbers, East Street, and certain leasehold houses, 127 to 133 odd numbers, City Road, and certain other leasehold houses, 135 to 139 odd numbers, East Street. On these premises the plaintiff had carried on a draper's business. The date of the structural damage occurred between April and October, 1901. The jury, in assessing the damages in the first instance awarded £50 in respect of the value of the subsoil taken, £2,100 in respect of damage to stock, £2,000 in respect of structural damage. At the trial before the late Mr. Justice Wright the claim in respect of the first item was abandoned. The late Mr. Justice Wright held that the plaintiff could not recover in respect of the freeholds, or in respect of 135 to 139, East Street, but was entitled to recover in respect of 7 to 13, East Street, a third of each of these sums. The plaintiff in his appeal claimed in respect of the freeholds his full claim, and asked that the decision so far as it related to structural damage should be allowed. On the cross appeal the defendants sought to reverse the decision in respect of 7 to 13, East Street. The freeholds at the time notice to treat was served upon the plaintiff belonged to Blake, the plaintiff having a leasehold interest, expiring at Christmas, 1899. Notice to treat was served on Blake in respect of the subsoil, and as to damage to be done, and on the plaintiff a like notice, but without prejudice as to whether the plaintiff had any interest in the subsoil. Subsequent to these notices Blake granted a new lease to the plaintiff. In 1900 Blake sold to the plaintiff the right to make and use a tunnel through the granter's property, to include satisfaction for all damages. Later, Blake sold the freeholds and his rights reserved to the plaintiff. The late Mr. Justice Wright held that the plaintiff was only entitled to claim in respect of the residue of the old lease, and that he had suffered no damage. Lord Justice Stirling, adopting the language of Lord Lindley in the case of Mercer *v.* Liverpool Railway Company, said "that a landowner," referring to Blake, "is only precluded from dealing with his property in such a way as to throw a larger burden in respect of compensation upon the undertakers. If this rule is not infringed he may sell and convey to a purchaser." After examining the deeds of conveyance he came to the conclusion, in which the other Lords concurred, that the effect of them was to put the plaintiff in possession of the right to claim for the structural damage. It was contended that this was an invalid agreement on the ground that it was a claim to a right to damages, but the Court did not agree with this contention. They considered that no greater burden had been imposed upon the defendants than if Blake had taken proceedings in his own name; they therefore upheld the claim in respect of structural damage. In respect of the claim for trade disturbance, since Blake would have had none, the plaintiff could have none. With reference to 135 and 139, East Street, these had been acquired by purchase by the plaintiff in 1879, and had about 48 years to run. The assignment of the terms to the plaintiff were accompanied by a document which assigned the rights of compensation to the plaintiff. The late Mr. Justice Wright had held this was in the nature of a claim for damages for a wrong. The Court did not agree, they thought that in effect this action was for the price payable by the defendant for the exercise of the legal right conferred upon them by statute. On this point of the case the appeal was accordingly allowed. With respect to the remaining leaseholds, the Court were of opinion in respect of 7 to 13, East Street, that the point not having been properly raised in the first instance, that it should only be allowed on terms of agreement between themselves or by a referee.

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LEGAL.

Irrelevant Ground of Action.—In discussing, on the ground of irrelevancy, an action brought against the Glasgow Corporation by a passenger suing for £1,000 damages in respect of injuries received while alighting from an electric tramcar, Sheriff Fyfe remarked on the number of cases in which no relevant ground of action was stated. "This record," said his Lordship, "like far too many of its sort, is simply an attempt to pile up a number of statements loosely strung together, and to cap the pile with a plea in law in general terms, in the hope of getting an order for proof. It is high time it were understood that this kind of record won't be accepted, and that the statements made must themselves each be relevant to the issue, and must have a relation to each other. Fault can only be founded upon specific and relevant averments of particular action, or want of action, in certain clearly-defined circumstances, and in this record there is no such averment."

"Lighted Tobacco" in a Tramcar.—At the Liverpool Assizes, on December 6, an action was brought against the Liverpool Corporation by Dr. E. F. Hall, of Prescot, to recover damages for injuries received at the hands of the conductor on one of the Corporation's tramcars. Plaintiff was a passenger on a car on June 22, and entered it smoking a cigar. He alleged that on taking his seat he ceased smoking, but admitted holding the cigar in his hand. He was required by the conductor either to put it out or leave. Plaintiff, however, protested that he was not smoking, and declined to leave. He gave the conductor his name and address, and the car proceeded, but subsequently the conductor again required him either to throw away the cigar or to leave the car, and upon his refusal the conductor, a powerful man, seized him and put him off the car, with the result that his leg was broken, and he sustained a severe shock. He was 67 years old, and was still suffering. The Corporation's case was that the conductor did what he was entitled to do, the plaintiff having refused to obey the bye-laws applying to his case. The breaking of the leg was described as a regrettable accident. Mr. Justice Walton held that although plaintiff's conduct was obstinate and stupid, it did not justify recourse to unnecessary violence. The jury awarded the plaintiff £1,000 damages, and judgment was entered accordingly.

The Purchase of Woolwich Tramways.—Major Carew sat, on December 9, at the Surveyors' Institution, Westminster, as arbitrator, to determine the price to be paid by the London County Council for the compulsory acquisition of the Woolwich and South-east London Tramway Company's system. Sir E. Boyle, K.C., Mr. E. Morten, and Mr. Leuchars were counsel for the Company, and Mr. G. M. Freeman, K.C., and Mr. G. Rhodes represented the London County Council. Sir E. Boyle, K.C., in opening the case, described the system in detail. He said there were 4½ miles of track, and this had been valued in two sections. Together these valuations amounted to £25,917. Then they claimed £2,085 for the offices and £17,316 for the depôt. For horses they claimed £5,172 and for cars £2,500. A sum of £25,000 was set down for street widenings, and other items made the total claim £85,813 2s. 8d. Twenty years ago local authorities were less assertive of their rights than they were now. No tramway could to-day be laid in such narrow streets as those through which these lines passed, and they claimed that it would cost £25,000 to make the streets the required width. A similar claim was made in the London, Deptford, and Greenwich tramways case, and was now before the High Court. Mr. Freeman said he should object to any evidence being called on this point. This was a claim for street widenings which never had been and never would be made by the Company. Should the claim be allowed the Company would put into its pocket £25,000 in respect of expenses which they had never incurred. If the street widenings had to be done now they would have to be done by the London County Council. Witnesses having been called, the proceedings were adjourned.

Electric Tramcars and Licences.—The case of the Yorkshire (Woollen District) Electric Tramways, Limited, *v.* Ellis, came before the Lord Chief Justice and Justices Kennedy and Ridley in the King's Bench Division on December 20. The appellants complained of a decision of the Justices of Dewsbury, who had convicted and fined them 2s. 6d. They were a light railway company, formed under Orders in accordance with the Light Railways Act of 1896, and the respondent, Mr Hiram Ellis, the Town Clerk of Dewsbury, summoned them for allowing one of their cars to ply for hire in the borough without a licence, his contention being that, under the Towns Police Clauses Act of 1847, the vehicle must be regarded as a hackney carriage. The magistrates had upheld this contention, and hence the present appeal. Mr. Danckwerts, K.C., who represented the tramway company, said the decision that a carriage run upon a light railway was a hackney carriage carried with it this absurdity, that a light railway must get a licence from every local authority through which the line ran, and there might be a great number of them. Consequently, although the railway company was bound to run such a number of cars as was necessary to meet the public requirements, each one of the local authorities would have the discretion of saying how many of these carriages there must be. Mr. Macmorran, K.C., who appeared for the respondent, supported the conviction on technical grounds arising out of several Acts of Parliament connected with tramways and other vehicles. The Lord Chief Justice said the point involved did the greatest credit to the ingenuity of the people who raised it. The Court, however, could not come to the conclusion that that which was in substance a railway was to be subject to the provisions of the Towns Police Clauses Act in regard to the licencing of hackney carriages. The absurdity of the thing was too great. The appeal, therefore, must succeed. The other judges concurring, the appeal was allowed with costs and the conviction quashed.

Deptford and Greenwich Tramways.—Mr. Justice Bray in the King's Bench Division, on December 15, considered a point in an award made by Mr. Henry Graham Harris in the arbitration between the London, Deptford, and Greenwich Tramways Company and the London County Council, which came before him by way of special case. In August, 1900, the London County Council decided to acquire the Company's undertaking. The Company and the Council differed as to the price to be paid, and Mr. H. G. Harris was appointed arbitrator in the matter. He found that the value was £91,373 7s. 6d. At the time the Company obtained Parliamentary powers for the construction of the line, it was not the practice to require the promoters of tramway undertakings to widen the streets through which the cars were intended to be run, or to make any contribution towards such widening. But if Parliamentary powers for the tramway had been obtained in 1900, the Company would certainly have been required to contribute one-third of the cost of street widening. The Company therefore contended that the present value of the undertaking was enhanced by reason of its being freed from the liability to contribute to such widenings. The arbitrator stated that in his opinion the contention of the Company was wholly unfounded. Should the Court, however, be of opinion that the contention of the Company should prevail, he awarded the Company £22,773 in addition to the sum of £91,363 7s. 6d. On December 21, his Lordship decided the case. He said that the street widenings had not, in fact, been made, and it was a startling proposition that the Council should have to pay, as part of the purchase money, for an expenditure which had never been incurred. It was admitted that the claim was a novel one, and that there was no authority to support it, and he had come to the conclusion that the arbitrator was right when he expressed the opinion that the contention was wholly unfounded. The Company's contention could not prevail, and, therefore, they were entitled to only £91,363 7s. 6d., and not to the additional £22,773 6s. 8d.

GLASGOW TRAMWAY MANAGERSHIP.

At a meeting of Glasgow Town Council on December 12 a report was submitted by the Tramways Committee regarding the appointment of Mr. James Dalrymple as general manager of the tramways. This stated that a sub-committee had considered the question of salary, and had agreed by six votes against three to recommend that the salary be £1,000 per annum, rising to £1,250 by annual increments of £50. The minority were in favour of a salary of £850 rising to £1,000. The sub-committee further agreed that the appointment should be subject to the following terms and conditions: (1) The appointment shall be held during the pleasure of the Corporation; (2) the general manager shall devote his whole time to the duties of the office; (3) the general manager, under the direction and subject to the control of the Corporation, shall have the full management of the tramways department; (4) the general manager shall appoint and control the entire staff, and shall have power to suspend or dismiss any person employed under him, and shall be responsible to the Corporation for the good conduct of the persons appointed by him and generally for the efficiency of the department under his management; provided always that before appointing or dismissing the head of any of the departments under him he shall submit the name of such person to, and obtain the sanction of, the Tramways Committee; (5) the general manager shall in such way and manner as the Corporation may direct, keep regular and distinct books and accounts showing the whole financial transactions of the tramways department, and shall, at such time as the Corporation may direct, deposit all monies received by him in bank; and (6) the general manager shall also, at such times as the Corporation may direct, submit accounts and statements showing the entire working of the tramways department; and shall, from time to time, make such returns and reports as the Corporation or the Tramways Committee may require.

The Tramways Committee voted on the salary recommended by the sub-committee and on two amendments, when a proposal that the salary should be £850, rising by £50 annual increases to £1,000, was carried by a clear majority. The sub-committee's report, subject to this change, was approved.

The Town Council, on the report being submitted, discussed the question of salary at some length, and by 31 votes against 29, fixed the salary at £1,000.

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NEW CONTRACTS AND ORDERS.

Sunderland Corporation have accepted the tender of the General Electric Company, Limited, for three-phase generators and motors.

Dick, Kerr and Company, Limited, have received an order from East Ham Borough Council for 10 car top covers, at £85 each.

S. Dixon and Son, Limited, have supplied one of their Turner's automatic 8-point controllers to the West Ham Corporation Tramways.

Torquay Town Council have accepted the tender of the Alphons Custodis Chimney Construction Company for the erection of the chimney stack at the new power-station, at £3,719.

The North Eastern Steel Company, of Middlesbrough, have secured the contract for the supply of tramway rails and fish-plates to the Leith Town Council, at £5 10s. per ton.

The British Electric Plant Company, Limited, have received a contract from the Alloa Coal Company for a complete direct-current electric power plant with engines for their Bannockburn colliery.

Messrs J. G. White and Company have secured the contract for the construction of Mansfield and District Light Railways at £48,000. Messrs. Bramwell and Harris are the consulting engineers.

The British Thomson-Houston Company, Limited, have secured the contract for the turbo-alternating electric plant required on the new sections of the Leeds Corporation tramways.

Leeds Corporation have accepted the tender of the Leeds Steel Works for the supply of 850 tons of steel rails at £5 7s. 6d. a ton, which is stated to be the lowest price steel rails have ever been secured at in Leeds.

Newport (Mon.) Corporation have accepted the following tenders for machine tools required by the tramways department: J. Hatch, wheel grinder, £125; Dempster, Moore and Company, machine tools, £225.

The British Westinghouse Electric Company have secured a contract for the supply of dynamos and switchboards to the extent of £40,000 for Belfast tramways, also a sub-contract for 400 controllers, from Messrs. J. G. White and Company.

Messrs. Mountain and Gibson, successors to the McGuire Manufacturing Company, have secured an order from West Ham Corporation for 35 trucks and 70 life-guards. The latter are of the Simplex type, the firm having acquired a right to manufacture these.

Burslem Town Council have accepted the following tenders for additions to their electrical plant: Callender's Cable Company, cables, £9,554; Messrs. Dick, Kerr and Company, engines and dynamos, £1,863; General Electric Company, Limited, balancer and booster, £337.

Gloucester Corporation have received the following tenders for an electric water sprinkler for the tramways:

	£
Dick, Kerr and Company, Limited (accepted) ...	550
British Thomson-Houston Company, Limited ...	557
Brush Electrical Engineering Company, Limited ...	565

Blackpool Corporation have accepted the following tenders for the construction of the new promenade tramway:

Walter Scott, Limited, for the supply of tram-rails, fish-plates, and anchor-joints.
Guest, Keen, and Nettlefold, Limited, for tie-bars.
Edgar Allen and Company, Limited, for points, connecting boxes, crossings, manganese steel rails, and drain boxes.
Bayliss, Jones, and Bayliss, Limited, for bolts, nuts, and washers.

Glasgow Corporation have accepted the following tenders in connection with the extension of the municipal tramway system from Pollokshaws East to Giffnock, viz., that of the National Conduit and Cable Company, Limited, for cables; that of the Howard Conduit Company, Limited, for conduits; and that of the Edison and Swan United Electric Light Company, Limited, for electric lamps.

Regenerative Control.—In the early part of December cars fitted with Raworth's regenerative control were put into operation at Birmingham, Bournemouth, and Havre. In each case a pattern of motor has been used which had not previously been tried, viz., Brush 1,002 B, Westinghouse 49 B, and General Electric 1,000. An order has also been received to fit up a car for the Corporation of West Ham.

Messrs. Thomas Oliver and Son, of 38, Victoria Street, S.W., have received an order for the construction of the portion of the new Cardiff railway between Tongwynlais and Treforest. This section is about 5½ miles in length. Sixteen tenders were received, the competition being exceptionally keen.

The Stalybridge, Hyde, etc., Tramway Board have accepted the tender of Underwood and Brother for joining their tramway with that of the Ashton-under-Lyne system; that of Dick, Kerr and Company for overhead equipment; and of Cook and Son for heating apparatus for the car shed, stores, and fitting shops.

Meldrum Brothers, Limited, of Manchester, have received from the Admiralty a contract for one of their well-known "Simplex" regenerative refuse destructors with steam generating plant. This is to be erected at Chatham Dockyard in connection with the large electric power plant which is being installed under the directions of Messrs. Preece and Cardew, the Admiralty's consulting engineers.

Cars for the Baker Steeet and Waterloo Railway.—The American Car and Foundry Company have given an order to Mr. A. K. Baylor for the cabinet work and other inside finishing required for the cars which the company will build at Trafford Park for the Baker Street and Waterloo Railway. The company have already made substantial headway in the arrangements for their works, which, as mentioned in a previous issue, will be erected on land adjacent to the British Electric Car Company's shops.

Stepney Borough Council have received the following tenders for the supply and delivery of conduits, troughs, and covers, for twelve months: Conduits: W. T. Henley's Telegraph Works Company (accepted), £1,807 13s. 4d.; J. Knowles and Company, £2,053 6s. 8d.; Albion Clay Company, £1,910 16s. 10d.; Siemens Brothers and Company, £1,840 13s. 4d.; Doulton and Company (informal). Troughs and covers: Siemens Brothers and Company (accepted), £1,235 13s. 4d.; do. alternative, £1,301 13s. 4d.; J. Knowles and Company, £1,917 13s 4d.; Doulton and Company £1,353; W. T. Henley's Company, £1,301 13s. 4d; do. alternative, £1,290 12s. 4d. An order has also been placed with Messrs. Babcock and Wilcox for an exhaust stack in connection with the extension of the generating station at £300.

Yarmouth Town Council have accepted the tender of Jacob Bros. and Company, a Belgian firm, for the supply of steel rails, fish-plates, sole-plates, tie-bars, and bolts, for the Gorleston tramways, at £4,665, 16s. The following tenders were received:

	£	s.	d.
Walter Scott (British) ...	5,651	10	0
North Eastern Steel Company (British) ...	5,400	2	6
Bolckow, Vaughan and Company ,, ...	5,257	12	6
Barrow Steel Company ,, ...	5,174	2	6
MacLellan and Company ,, ...	5,141	0	0
A. Penny and Company (Belgian) ...	4,919	7	6
Le Bas and Company ,, ...	4,749	8	2
Jacob Bros., and Company ,, ...	4,665	16	0

Fourteen tenders in all were sent in. The six not quoted above were incomplete.

Erith Urban Council have received the following tenders in connection with their tramway undertaking:

	£	s.	d.
Messrs. Mountain and Gibson, track sweeping and watering car	650	0	0
British Thomson-Houston Company, Limited, tramcars ...	8,189	10	0
Ditto, track sweeping and watering car ...	608	0	0
Messrs, Dick, Kerr and Company, tramcars ...	8,935	0	0
Ditto, track sweeping and watering car...	668	0	0
Messrs. Hurst, Nelson and Company, tramcars ...	7,528	0	0
Ditto, track sweeping and watering car ...	568	0	0
Brush Electrical Engineering Company, tramcars ...	8,278	0	0
Ditto, track sweeping and watering car ...	680	0	0
British Westinghouse Electrical Manufacturing Company, with Brush Company's cars ...	8,628	15	0
Ditto, alternative offer with Hurst-Nelson cars ...	8,025	0	0
Ditto, track sweeping and watering car ...	608	0	0
St. Louis Car Company, cars ...	9,279	0	0
Messrs. Witting, Eborall and Company, tramcars...	7,682	0	0
Ditto, track sweeping and watering car ...	573	0	0

The St. Louis Car Company stated that they proposed to erect and equip the cars at Erith, and as far as possible, employ local labour. The tenders were referred to the consulting engineers.

Belfast and Monte Video Tramway Contracts.—The following additional information in regard to the large contracts for Belfast and Monte Video, which we recently announced had been secured by J. G. White and Company, Limited, is of interest. As regards the Belfast contract, it is divided into six sections. First is the permanent way, which includes the construction of 28½ miles of double track, and the repairing and bonding of 8 miles of double track and two of single. The new rails will be British standard, Nos. 4 and 4c. The concrete bed will be 7 in. thick, and granite setts will be employed. The value of the special work amounts to £25,000. The second section consists of 37 miles of overhead construction, mostly span wire. The trolley wire is 4/0 S.W.G. Section 3 is the cables, comprising feeders, telephone and test cables. The feeders will be laid on the solid system in earthenware troughs filled in with bitumen. The di-electric is vulcanised bitumen. The fourth section includes engines, dynamos, switchboard, condensing plant, etc. There will be three engines and direct-current dynamos of 1,000 KW. each, and running at a speed of 180 revolutions per minute; two 250-KW. three-phase motor generators; two 125-KW. three-phase motor generators; and a 25-ton crane. The fifth section is the boiler-house, containing four boilers (170 lbs pressure), superheaters, mechanical stokers, coal and ash conveying plant, and the usual piping. The sixth section is the supply of 170 electric cars. As regards the Monte Video contract, this involves the reconstruction of 51 miles of permanent way and the provision of the accompanying overhead construction. The number of cars to be supplied is 100. The power-station will contain generating sets to the amount of 2,000 KW.

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PERSONAL.

Mr. J. W. Turner has been appointed chief assistant at Huddersfield Corporation Electricity Works.

Sir Edward Grey has been elected chairman of the North Eastern Railway Company in succession to the late Viscount Ridley.

Mr. S. Woodfield has resigned his position with the British Thomson-Houston Company in order to join the staff of J. G. White and Company, Limited.

Mr. Walter H. Wood, general manager of the Hull and Barnsley Railway, has been appointed by the Secretary for India to be a member of the Indian Railway Board.

Mr. John Metcalfe, the late manager of the Gateshead and District Tramway Company, has entered the employment of the British Johns-Manville Company, Limited, of Fenchurch Street, E.C.

Mr. Joseph Carter has been appointed secretary of the Metropolitan District Railway in the place of Mr. William Jones, who retired at the end of the year.

The Earl of Lauderdale has been elected chairman of the Great Northern and City Railway in succession to Sir Chas. Scotter, who has resigned.

Mr. T. Lewis, permanent way inspector of the Leicester tramways, has been appointed permanent way inspector by the Belfast Tramways and Electricity Committee.

Mr. H. H. Heayberd, formerly in the employment of R. W. Blackwell and Company, Limited, has been appointed outside equipment assistant by the Hull Corporation tramways department.

Mr. Daniel Creedon (son of the late manager) has been appointed manager and permanent way inspector of the Schull and Skibbereen Tramway Company. Eleven applications were received for the post.

Mr. R. P. Ellis, assistant superintendent of the Great Eastern Railway, has been appointed chief superintendent of the line, and took over the duties from January 1, on the retirement of Mr. H. G. Drury.

Mr. A. H. Burbidge, who was resident engineer to Messrs. Kennedy and Jenkin during the construction of the Kilmarnock electric tramway system, has been appointed electrical engineer and tramway manager for the Corporation of that town.

Mr. W. F. Endean, chief inspector of the Devonport and District Tramways Company and brother of Mr. J. W. Endean, manager of that company's system, has been appointed manager of the Middleton Electric Traction Company's tramways.

Mr. A. T. Smith, chief assistant electrical engineer to Bury Corporation, has been appointed electrical engineer to the Leigh Corporation Tramways and Electricity Committee, at a salary of £250 per annum. There were 147 applicants.

Mr. Earnest H. Hiley, district superintendent of the North Eastern Railway at York, has been appointed chief passenger superintendent of the Great Northern Railway, consequent upon the retirement of Mr. George Mason.

Mr. William Barclay Parsons, who has been chief engineer of the Rapid Transit Commission of New York, has resigned and will devote himself to the work of the Panama Canal Commission, of which he is a member, and to general practice.

Mr. Cyril M. Shaw, of Wakefield, has been appointed electrical engineer to the Worcester Corporation at a salary of £400, rising by annual increments to £500. Mr. Shaw received 29 votes to 7 given for the second selected candidate, and 5 for the third. There were 95 applications.

Mr. A. A. Blackburn, A.M.I.E.E., car shed superintendent of the Manchester Corporation Tramways, has been appointed car works superintendent to the Belfast Corporation Tramways. Mr. Blackburn has been with the Manchester Corporation Tramways for over two years. He takes up his new duties in Belfast on February 1.

Mr. Walter Binns, the Reading Corporation tramways manager, has been voted an increase of salary from £300 to £400 a year, rising further by two annual increments of £50 to £500 per annum. This was granted on condition that Mr. Binns agreed to remain in the service of the Corporation for a period of three years.

Mr. Henry Evans, of the Glasgow and South Western Railway, has been appointed by the directors of the Midland Railway Company, to succeed Mr. W. E. Adie as goods manager from March 1 next. Mr. Eaton, the superintendent of the line, who has been with the company nearly 43 years, has resigned.

Mr. John Young, formerly manager of the Glasgow Corporation tramways and now general manager of the Metropolitan District railway, was welcomed in London on December 13 by some three or four hundred fellow-Scots at a smoking concert under his chairmanship at the Great Eastern Hotel.

Mr. Alfred H. Gibbings, consulting electrical engineer, informs us that owing to the completion of his engagement with the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board on December 31, all communications of a personal nature should be addressed to "Lynton," Wellington Road North, Stockport.

Councillor Shentall has recently succeeded Alderman J. Pierson as chairman of Chesterfield Corporation Tramways Committee. Mr. Pierson was chairman of the committee when the electrification of the horse tramways was determined upon, and it was largely due to his efforts that the Council have so energetically carried out their scheme that cars have so soon been put in regular service.

Mr. J. E. Teasdel, the Cardiff Corporation deputy-engineer and assistant tramway manager, has been presented by the electric light and tramway employees with a gold watch and chain, a case of cutlery, and a cigar-case, on the occasion of his departure to take over the managership of the Pontypridd Corporation tramways and electric lighting systems.

Mr. A. J. Lawson, M.I.C.E., M.I.E.E., who for the last three years has held the position of chief electrical engineer to the British Electric Traction Company, Limited, having tendered his resignation in September last, severed his connection with the company on December 31. He will continue to practise as a consulting engineer at his present address, 4, Adelphi Terrace, Strand, W.C.

Mr. H. G. Drury, superintendent of the Great Eastern Railway, retired at the end of the past year. He has been in the service of the company since its inception in 1862. Prior to that date he was for nine years in the employment of the Eastern Counties Railway, which became incorporated with the G. E. R., so that Mr. Drury has altogether devoted over 50 years of his life to railway work.

Mr. John Baynes, M.I.Mech.E., who represented the Wallace Supply Company of Chicago, U.S.A., in this country, was found dead and entirely covered by water in a bath at his flat in Victoria Street, London. At the inquest, on December 6, the medical evidence was that death, which was due to heart failure, must have taken place six or eight hours before the discovery.

Mr. Thomas Scott, A.M.I.M.E., for many years chief engineer and manager for Messrs. Macartney, McElroy, and Company, Limited, has severed his connection with that firm, and has commenced business as consulting and contracting engineer, at 3, London Wall Buildings. His wide experience in all classes of electric traction work both at home and abroad should ensure his success in his new undertaking.

Mr. Webster, engineer at the Shrub Hill power-station of the Edinburgh and District Tramway Company, received a tribute in the Board of Trade report on the recent explosion for the promptness of his action in closing the steam connections. He effected this at grave personal risk and injury, and the danger which threatened the occupants of the boiler-room was thus averted. An abstract of the report appears in our Tramway Notes column.

Mr. J. Barber Glenn, the popular secretary of the Belfast and other tramway companies, on New Year's Eve drove home the last tramcar under the auspices of the Belfast Street Tramway Company, the Corporation taking possession of the lines on January 1. Thirty-two years ago Mr. Glenn drove the first car on the Belfast streets, and since then he has been actively associated with tramway undertakings throughout the Unitd Kingdom, his name being well known as a pioneer of electric traction.

Councillor J. S. Dronsfield has been appointed chairman of the Oldham Tramways Committee. After the last municipal election Councillor J. Middleton, who was then vice-chairman, was appointed to the vacant chairmanship. This was a non-political selection, and was based simply on the latter gentleman's long experience on the Tramways Committee. It has since been thought desirable to introduce the political element, and, as Councillor Middleton's party is now in a minority, he thus vacates the chair in favour of Councillor Dronsfield.

Mr. W. H. Dixon, who is well known to tramway men as the secretary of Hadfield's Steel Foundry Company, Limited, has been appointed a director of that company. The promotion comes as a well-deserved recognition of the energetic work which Mr. Dixon has done for the company during an important phase of its history. Our readers are familiar with the enterprise shown by the Hadfield Company in undertaking the manufacture of special track-work for tramways, and the success which the company has achieved in this direction is due in no small measure to Mr. Dixon's assistance.

Mr. J. B. McDonald has resigned his directorship of the Interborough Rapid Transit Company, and the Rapid Transit Construction Company, of New York, these being the companies concerned in the New York Subway, for the construction of which Mr. McDonald was the original contractor. On December 14 he was elected a director of the Metropolitan Securities Company, which controls the surface transportation system of New York. Mr. McDonald has announced that his efforts will be devoted towards securing for the Metropolitan Company its proposal to the city to build an independent subway on the east side of New York from the Battery to the Bronx, which would provide lateral connections with the company's surface cars without additional fare.

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Mr. E. Kilburn Scott, M.Inst.E.E., A.M.Inst.C.E., has been appointed to organise and take charge of the Electrical Engineering Department at Sydney University. In addition to lecturing duties he will continue his consulting practice. Mr. Kilburn Scott is a native of Leeds and went through the shops and drawing office of John Fowler and Company, the well-known locomotive engineers. He was afterwards with the Brush and Electric Construction Companies and with Messrs. Johnson and Phillips. He has of late years been closely identified with traction work in connection with the Bath tramways, the undertakings of the North Wales Power and Traction Company, and the Sunderland District Electric Tramway Company, for which he drew up the specifications and advised on the electrical details generally. Mr. Kilburn Scott has been for many years a regular contributor to the technical press and has consistently advocated alternate current traction. He was author of the first book published on "Local Transmission of Power in Workshops, etc.," and his paper on "Coal Cutting by Machinery," was awarded a premium by the Institution of Civil Engineers.

Presentations to Mr. Andrew Nance.—Mr. Andrew Nance, hitherto general manager for the Belfast Tramways Company, and now appointed to the similar position for the Belfast Corporation, was on December 28 presented by the tramway employees with his portrait, pieces of plate, and addresses. The whole tramway staff, including those employed in the offices, took part in the presentations, all desiring to show their esteem for the general manager. Mr. Nance had unfortunately been seriously ill recently, and he had not recovered sufficiently to receive the testimonials in the public manner which the employees would have liked. Accordingly the presentations were made at his private residence by a representative gathering of the staff. The portrait of Mr. Nance, which was presented, was painted by Mr. Harry Douglas, a local artist. The plate took the form of three massive solid silver bowls for Mrs. Nance. One of the addresses, which is from the drivers and conductors, is contained in a handsome album, and is beautifully illuminated. The subscribers who signed their names to it number about 300. Other pages of the album are taken up with photographic views of the city. The other illuminated address was presented by the staff, aud is elaborately framed.

Mr. J. H. Fooks-Bale, M.I.E.E., M.I.M.E., has been appointed electrical engineer and tramway manager for the Walthamstow Urban District Council. There were 69 applicants for the position, but a special committee of selection reduced them to eight. These gentlemen were interviewed by the full Council in Committee, with the result that two of the candidates were selected for the appointment, viz: Mr. Fooks-Bale and Mr. J. Pattinson Thomas, of the Great Northern and City Electric Railway. Upon a vote being taken, Mr. Fooks-Bale was appointed. The Walthamstow Council are to be congratulated upon their choice of a tramway manager, for in Mr. Fooks-Bale they have a gentleman of thorough experience. During the three years he was chief assistant to Mr. C. H. Wordingham, at Manchester, he had the training of some 2,000 tramway-men, and the supervision of the staff for repairing 500 cars. In this connection both Mr. J. M. McElroy, the general manager of the Manchester Tramways, and Mr. Wordingham speak of Mr. Fooks-Bale in the highest terms. Another point in his favour was the fact of his having had practical experience with Westinghouse gas engines of similar size to those installed at Walthamstow. The applications for the post of traffic superintendent will probably be dealt with in a few days.

TRADE PUBLICATIONS.

John Thom, of Patricroft, issues four copiously illustrated catalogues of boring plants, water-raising appliances, waterworks fittings, and steam valves and fittings.

Air Compressors.—A valuable catalogue of air compressors is issued by Peter Brotherhood, of Belvedere Road, Westminster Bridge, S.W. Single, double, and three-crank machines are supplied by this firm, and the working of these and other combinations is elaborately illustrated and described.

The United States Packing Company have issued their usual wall calendar. This year the calendar is decorated with an artistic reproduction of the figure of Atalanta, executed in bas-relief and tinted by reflection as from a fire. The colouring is admirably done, and the calendar will be much appreciated by recipients.

Electric Radiators.—The General Electric Company, Limited, have an excellent range of electric radiators; some of these are of decidedly handsome design, and all are of undoubted utility. The advantages of this clean and healthy form of heating should be more generally recognised, and the handy little list issued by the G.E.C. will remove any impression that the prices are at all prohibitive.

The Underfeed Stoker Company, Limited, of Coventry House, South Place, Finsbury, E.C., have just published a new catalogue descriptive of their underfeed stoker for the smokeless and economical combustion of coal. The advantages attending the use of an established system of mechanical underfeed stoking are duly set forth in this publication, which contains much of interesting and instructive matter.

Messrs. Dick, Kerr and Company issue two very handsome books entitled respectively "Continuous Current Generators" and "Alternating Current Machinery." The former, which may be described as an *édition de luxe*, deals with the manufacture of large continuous current generators, and is embellished with 17 admirable half-tone engravings. The other publication treats of the construction of various types of three-phase generators and sub-station plant, and briefly sets forth the principal features of the Preston machines. Some excellent illustrations and diagrams are included.

Rheostatic Controllers and Resistances.—Under this heading, the British Thomson-Houston Company, Limited, publish their pamphlet number 177. Several illustrations are included, showing controllers both for continuous and alternating currents. The application of the former type to travelling cranes, factory locomotives, electric jennies, hoists, winches, lathes, and a Cotterell press are also illustrated. The British Thomson-Houston Company claim for their controlling device the following valuable features, viz., a large number of controlling points, removable covers, interlocking arrangements, and interchangeable parts.

Peckham's Solid Forged Cantilever Truck.—We have received a copy of the Peckham Manufacturing Company's new catalogue, issued from Mr. Edgar Peckham's London address at No. 34, Albemarle Street, W. The special feature of this publication is the description of Messrs. Peckham's extra long "solid forged" cantilever truck, which has been designed for 18 and 20-feet double-decked and 22-feet single-decked cars. Its essential features are: A long spring base, supported from underneath by a cantilever truss; graduated car supporting springs, that regulate the spring pressure so as to ensure an easy riding car, whether light or heavily loaded; a quick-acting, powerful brake, and self-lubricating, dust-tight journal boxes. The improved side frames consist of two continuous horizontal (mild) steel or iron bars rolled or forged without joint or weld, supported from underneath by a cantilever truss, that sustains the entire weight of the end extensions of the main side bars that support the car body springs The gears for supporting the side frames upon the journal boxes depend upon the wheel-base of the truck. For a short wheel-base (6 to 7 feet) the pendulum gear is used, while for a wheel-base of from 7 to 9 feet the radial gear is applied. Diagrams follow showing sectional views of the truck and of the pendulum and radial gears. Other specialities of Messrs. Peckham are illustrated and described, and several testimonials from users of Peckham trucks in the United Kingdom are included. The introduction, "How to select your trucks," is independent of the advertising matter, and contains some useful hints.

ELECTRICAL TRAMWAY EQUIPMENT FOR JAPAN.

On December 27 a special train consisting of 42 wagons left Dick, Kerr, and Company's Preston works, carrying 250 tons of electrical machinery, being shipped in connection with that company's contract for the complete equipment of the Tokyo Denki Tetsudo Kabushiki Company's tramways. This tramway system, when finished, will cover over 60 miles of line, and will require some 250 cars. The complete installation is being carried out by Dick, Kerr, and Company, under the supervision of a staff of their engineers, and it is surprising to learn that the only effect the war has had on the progress of the work is in connection with the transportation of the machinery from Yokohama to Tokyo, the railway being congested with war material.

REGULATIONS FOR HEAVY MOTOR TRAFFIC.

The Local Government Board have issued their regulations in regard to heavy motor traffic twelve months after the Motor-car Act of 1903 came into force. The maximum weight allowed for an unladen motor-car has been raised from three to five tons, and a corresponding increase has been made in the joint unladen weight of the motor-car and trailer, viz., from 4 to 6½ tons. All automobiles over two tons in weight (unladen) are classed as heavy motor-cars under these regulations. The joint weight of any heavy motor-car and its load is restricted as follows: Total weight of car and load is not to exceed 12 tons; the weight borne by any axle is limited to eight tons, and no axle must at any time be permitted to go beyond the weight accepted for that axle at the time of the registration of the car. No ordinary tyre (not pneumatic or made of a soft or elastic material) may be less than five inches in width. It is not thought necessary to prescribe the width of pneumatic tyres, or those of a soft or elastic material, as the practical necessities in such cases will doubtless be enough to secure the selection of tyres of suitable strength and durability, and consequently of adequate size. The rate of speed allowed to motor-cars generally by the Act of 1903 is considerably reduced for heavy motor traffic under the new regulations. This traffic is now restricted to eight miles an hour, or to five miles an hour if the car exceeds three tons in weight unladen, or has any axle with an axle weight exceeding six tons, or draws a trailer.

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FINANCIAL REPORTS AND COMPANY MEETINGS.

East India Tramways Company, Limited.—The directors recommend a dividend at the full rate on the 5 per cent. cumulative preference shares, carrying forward £83.

Melbourne Tramway and Omnibus Company, Limited.—The directors of this Company have declared a dividend at the rate of 10 per cent. per annum for the past half-year.

Cape Electric Tramways.—An interim dividend of 2½ per cent., free of income-tax, has been declared, payable to all shareholders registered on 9th January, and to holders of coupon No. 18 attached to share warrants to bearer.

Bath Electric Tramways, Limited.—The directors have declared a dividend at the rate of 5 per cent. per annum upon the cumulative preference shares, calculated from the due dates of the various instalments to December 31, 1903.

Provincial Tramways Company, Limited.—The directors recommend a final dividend of 3s. per share on the ordinary shares, making 6s. per share for the year to September 30, placing £7,000 to depreciation, and carrying forward £3,400.

Maidstone Urban Council have decided to borrow from the Royal Insurance Company, the sum of £25,000, required for the Corporation tramway. The money is to be repaid in 40 years, and the rate of interest is 4 per cent.

Castle Car Syndicate, Limited.—This Company was registered on December 6, by Linklater and Company, 2, Bond Court, Walbrook, E.C., with a capital of £1,000. Its objects are to acquire railway, tramway, and other car and carriage works, to manufacture and deal in cars, rolling stock, and vehicles, etc.

Cairo Syndicate, Limited.—This Company was registered on December 16, with a capital of £15,000. Its objects are to adopt an agreement with E. C. Nichols, and to carry on the business of concessionaires, explorers, financiers, builders, contractors, railway and tramway proprietors, etc., in Egypt or elsewhere.

A Russian Tramway Undertaking.—The *Svet* announces that Siemens and Halske are organising an independent joint stock company for the purpose of working the concession of the Warsaw electric tramways system. The capital of the Company will be 15,000,000 marks, and there will be 10,000,000 marks debentures.

Dundee Corporation Tramways show, for the first half of the current year, a very satisfactory financial position. The estimated expenditure for the six months was £13,550, while the actual outlay amounted to £120 less. With regard to the revenue, the estimate for the same period was £22,083 10s., and the actual income was £23,165 4s., or £1,081 14s. better than was anticipated.

Sheffield City Tramways.—The gross receipts of the Sheffield City Tramways for the year just ended amounted to £235,939. The receipts for 1903 were £228,743 17s. 10d., the increase therefore being over £7,000. In 1900 the receipts were £121,117 2s. 1d., the amount having been more than doubled during the past five years. The average takings for the last three months have been £4,498 11s. 2d. per week.

Dorchester and District Electric Supply Company, Limited—This company was registered on December 13, with a capital of £1,000. Its objects are to construct cables, accumulators, lamps, etc., and to carry on the business of electrical engineers, suppliers of electric light and power, tramway proprietors, etc. The registered office is at 11, Carteret Street, Queen Anne's Gate, Westminster, S W.

Shropshire, Worcestershire, and Staffordshire Syndicate, Limited.—This company was registered on December 16, with a capital of £10,000. Object, to carry on the business of producers, suppliers, buyers, sellers, and users of electrical energy for all purposes, engineers, metal and wood workers, agents, railway and tramway proprietors, contractors, etc. Office: 53, Victoria Street, Westminster.

Edinburgh Street Tramways Company.—The sale to the town of Leith of the company's remaining tramways having now been carried through, the directors are, in pursuance of the company's Act of 1896, proceeding to wind up the company's affairs. The remaining assets are of such a nature that they cannot be wholly realised at once, but the directors resolved to make, on January 7, an interim distribution of 16s. per share.

Raworth's Traction Patents, Limited.—This Company has now been formed to acquire the British patents granted to Mr. J. S. Raworth for the system of automatic regenerative control of electric tramcars. The capital is £30,000, equally divided into preferred and deferred shares. The former were offered to the public. Letters of allotment were posted on December 23. The company commence business with orders for equipment for 65 cars.

Aberavon District Tramways Syndicate, Limited.—This company has been registered, with a capital of £2,000, in order to apply for a Provisional Order or Act of Parliament authorising the construction of an electrically-equipped tramway in the parishes of Aberavon and Margam, Glamorgan, and elsewhere; to construct or acquire tramways, etc., and to maintain, develop, and work the same. Registered offices, Arlington Chambers, 4 and 5, Commercial Street, Newport, Mon.

New South Wales Tramways.—The report of the Railway Commissioners on the State-owned tramways for the quarter ended September 30 last has been issued. The tramways comprise 125¾ miles, and are mostly worked by electric traction. During the three months under review 33,271,372 passengers have been carried, the revenue amounted to £192,351 and the expenditure to £162,912. These figures compare favourably with the corresponding period of the previous year. The receipts have increased by £6,511 and the expenditure by £3,673, the net improvement being thus £2,838.

Manx Electric Railway Company, Limited.—The directors' report for the year ended September 30 last, states that the gross receipts amounted to £30,818, and the expenditure to £17,279, leaving a net profit of £13,538. To this must be added the balance brought forward from last year, £3,266. After paying the preference share dividend there remains to be carried forward £780. During the year a large amount has been spent out of revenue in raising and ballasting the Douglas and Laxey track and also the Snaefell Mountain track, and the whole line has been kept in a good state of repair. Upon capital account there has been expended during the year £20,414 in the completion of the new generating plant and equipment, on rolling stock, the erection of car sheds, goods sheds, and other works. The sum of £1,000 has in addition been set aside out of revenue towards a renewal fund.

Wolverhampton Tramways.—A balance-sheet has been submitted to the Wolverhampton Town Council dealing with the result of the working of the Lorain system of tramways now in operation during the six months ended September 30 last. The total receipts are stated to be £18,678, as against £12,460 in the corresponding period of last year. The total receipts per car-mile were 11·85d., as against 11·2d. in the corresponding period. For maintenance and renewals the total cost was £869; average cost per car-mile ·55d., against £825 and ·74d. last year. The total cost of the Lorain equipment is set down at £379, as against £244 last year. The total general costs amount to £1,204, as compared with £1,101 last year, The total working costs are £9,911, against £7,799 last year. The balance-sheet shows a profit of £1,442 on the six months as compared with a loss of £262 in the corresponding period of last year.

Isle of Thanet Electric Tramways and Lighting Company, Limited.—The directors' report for the year ended September 30 last, shows a balance at the credit of profit and loss account of £13,493 4s. 9d. The traffic receipts amount to £35,005 4s. 11d. as against £33,465 for the corresponding period of last year, and the sale of electricity to £2,291 against £904; the total receipts for the year being £37,620 against £34,677, an increase of £2,943. To pay the debenture interest, dividend on preference shares, interest on loan, fees to debenture trustees, and income tax, an additional sum of £2,454 2s. 2d. was required, which has been taken from the unappropriated balance at the credit of last year's revenue account. Owing to objections raised by the Board of Trade to the double truck cars it became necessary to alter them, and to mount them on single trucks at a cost of £1,833 2s. 2d., and the balance of the special account for "improvement and reconstruction of cars" (£1,800) will be written off revenue in six annual instalments.

British Electric Traction Company Limited.—The interim report of the British Electric Traction Company, Limited, states that the directors have not undertaken new obligations of any magnitude, and the policy of restricting capital commitments as much as possible for the present has enabled them to reduce considerably the administration expenses, whilst some promising schemes are kept in reserve to be dealt with when conditions are more favourable. There has been an increase in the aggregate traffic receipts of the associated companies, although, owing to the general depression in trade which has prevailed during the year, the increase has not been so large as was anticipated. It is hoped, however, that, with the expected revival in trade, there will be a further improvement in traffic receipts and in the income from the company's investments, which last year yielded £136,238. The directors have declared the usual interim dividend at the rate of 6 per cent. per annum upon the ordinary shares for the six months to September 30 last.

Newcastle Corporation Tramways.—The Tramways Committee have issued a report embodying the revenue account in connection with the system for the half year ended September 29 last. After interest and redemption have been provided for, there remains a balance of income over expenditure of £3,413 5s. 5d. The expenditure is stated as follows: To power, pumping, sub-station, and distribution expenses, £5,288 5s. 8d.; public (street) lighting, £268 17s. 9d.; general expenses, £8,541 7s. 7d.; traffic expenses, £36,924 7s. 7d.; maintenance, £16,401 7s. 5d.; total, £67,424 6s. The receipts were: Traffic receipts, £100,194 1s. 5d.; receipts for car damage, £22 13s. 6d.; advertising, £139 10s. 6d.; public (street) lighting, £1,430; rents (shops, etc.), £265 3s. 1d.; public supply receipts (for lighting public buildings, etc.), £136 16s. 2d.; sundry receipts, £60 18s. 5d.; total, £102,239 3s. 1d. From the surplus of £34,814 17s. 1d. thus shown, £16,805 13s. 1d. has been deducted for interest, and £14,595 18s. 7d. for redemption, leaving a net balance, as stated above, of £3,413 5s. 5d.

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Douglas Southern Electric Tramways Company.—The ninth annual general meeting of this company was held in Manchester on December 29, the chairman (Mr. T. J. Hutchinson) presiding. The report and statement of accounts showed that the company's season this year consisted of 134 days, as against 123 days last season; whilst the mileage run was 35,075·99, as against 32,343·77 last year. Notwithstanding the splendid summer, there had been a great falling off in visitors, caused by the crisis in the cotton trade, and the Manx season had suffered severely. It was a matter for congratulation that the receipts had kept up very fairly—being only £176 below those of last season. The total receipts this season were £4,785, as against £4,961 in 1903. The net profit for the year was £1,681, as against £1,965 last year, which, added to £209 balance from last year, gave a total disposable balance of £1,890. The directors recommended a dividend of 6 per cent. upon the preference shares, which would absorb £1,558, and leave a balance of £332 to be carried forward, subject to directors' fees. From November 1, 1905, an additional payment of 5 per cent. of the gross receipts became due to the Marine Drive Company.

British Thomson-Houston Company, Limited.—The ordinary general meeting of the shareholders of the Thomson-Houston Company, Limited, was held on December 15, at the company's offices, Cannon Street, London, Mr. W. A. McArthur, M.P., presiding. The chairman said that in the preparation of the accounts the directors had adopted a fairly drastic method of valuation of the property. They had, with the acquiescence of the principal shareholders, adopted the policy of making large repayments of the development charges, which had been necessary in the company's business, as they always were in any business which assumed such large proportions. They had adopted that policy deliberately, because they believed that it added to the safety of the company to have those charges paid as quickly as possible. It was felt that the main object of the company should be, not so much the distribution of profits, as to place the company in the strongest position by clearing off the development charges essential in so large a manufacturing business. There were still some of these charges to be dealt with; but they would soon cease, and then the company might fairly hope to enter on what he hoped would be a long and profitable career. The report was adopted.

West Ham Corporation Tramways.—The accounts of the West Ham Corporation Tramways for the half-year ended September 30 last are issued in the standardised form, as approved by the Municipal Tramways Association. The receipts for the period were £27,748, equal to 11·85d. per car mile, and there was also an estimated additional revenue of £3,000 from horse-car lines worked by the North Metropolitan Tramways Company, making a total of £30,748. The working expenses were £16,588, or 7·08d. per car mile, the total including £1,000, equal to ·43d. per car mile as proportion of the cost of a car shed. The purchase price of current was 1·6d. per Board of Trade unit, and the cost for it per car mile was 1·42d. There was a further expense of £762 for repairing the permanent way of the horse lines worked by the North Metropolitan Company, so that the total expenses came to £17,350. The balance carried to net revenue account was £13,398, and after paying £4,549 as interest and £2,163 as contribution to sinking fund, a sum of £4,000 was transferred to the borough rate, and a balance of £3,016 was put to reserve or renewals fund. The latter figure included £330 brought forward from the previous half-year. The capital expenditure stood at £196,538. The car-miles run numbered 561,832, the passengers carried 7,632,604, and the current used per car-mile was ·88 unit. These results must be thoroughly satisfactory to the ratepayers, and they indicate that in Mr. Blain the Council have secured a tramway manager of much administrative ability.

Gloucester Capital Expenditure.—At a meeting of Gloucester Town Council, on December 28, Mr. R. Fream, Chairman of the Tramways Committee, gave the following details of expenditure on the tramways: Track construction, £68,537 18s. 2d., less cost of wood blocks (£6,000); overhead equipment, feeder pillars, cables, etc., £12,967 12s. 4d.; cars and rolling stock, £13,212; depôt buildings, £5,736; provisional order, £1,358 16s. 7d.; engineer's fees, etc., £2,695 14s. 6d.; tools and miscellaneous expenses, £2,401 13s.; total £101,000. The purchase of the horse tramways cost £26,310, less £3,445 for re-sales. The county portion of the system had cost £16,154 16s. 3d., the gross total expenditure of the entire undertaking being £140,020 1s., or within about £20 of the estimate made by Mr. Fream in November, 1903. That, he considered, worked out very satisfactorily, considering the amount included the cost of 10 extra cars, 1¼ miles of extra single track, special work at the Cross, and other unforeseen details. With reference to the £26,000 for the purchase of the old tramways, the credits to be set against that were £3,445 8s. 6d. produced by sales of old materials, etc.; £4,713 12s. 9d. value of setts used in reconstruction after deducting the cost of re-dressing; value of rejected setts aporopriated to the repair of streets, £502 11s. 8d.; the India Road land and depôt, £4,400; the cost of the Company provisional orders, £1,500; and sundries retained, £250—a total of £19,511 12s. 11d., which meant that the Company's goodwill, the full control of their roads, and the saving of very heavy traffic, costing them £2,000 or £3,000 in street repairs, had been acquired for £6,488 7s. 1d.

Blackpool Electric Tramways (South), Limited.—A special meeting of the debenture holders of this company was held at Liverpool on December 22, Mr. J. S. Harmood Banner, as senior trustee, presiding. Representatives of about £85,000 debenture stock were present. The meeting was called to consider a scheme for writing off 20 per cent. of the debenture stock, and asking sanction to pay 3½ per cent. interest on the stock instead of 5 per cent. on the balance for the next eleven years: at the end of that period, if the company achieved the success anticipated, the sum written off the debentures was to be reinstated, and the difference between 3½ per cent. and 5 per cent. paid on the whole stock. The chairman explained the course he had taken was in the interest of the debenture holders, and said that, as one of the trustees, he paid over the debenture holders' money only when he received the engineer's certificate that the line was satisfactory. After a long discussion, Messrs. Percy Musgrave (Bolton), A. M. Sing (Liverpool), and Joseph Wilson (Liverpool, were appointed to associate with the trustees (Mr. Harmood Banner and Alderman Joseph Heap) as a committee to consult as to the best course to be taken in the interest of the stockholders. This committee was empowered to raise £10,000 to meet the immediate requirements of the company, to meet the expenditure necessary in obtaining Parliamentary powers for running into Blackpool, to finish the construction of the tramway, and to appoint managers of the undertaking. Thereupon the consideration of the financial scheme was postponed to another meeting of the stockholders, to be held on a date to be fixed by the trustees.

South Staffordshire Tramways Company.—The annual meeting of this company was held on 14 December at Winchester House, London. Mr. W. Somers L. Schuster, who presided, said that for the last ten years the board had had a very difficult task, but he was glad to say they had come to a settlement with the lessee company, which, to his mind, would be of material benefit. The offer made by the lessee company, in a circular of July 1, 1904, had been accepted by proprietors holding £77,405 ordinary stock and £58,240 preferred capital, which represented a very considerable majority. The lessee company was now very much the largest shareholder in the old concern, and it was just as much in their interest as in that of the other shareholders to do all that was possible with the company. They had a total of £1,590 available for distribution, and out of this it was proposed to devote to dividends a sum of £1,583, which left the very small sum of £7 to carry forward. This meant a dividend of 2s. 10d. for the year 1903, and one of 1s. 4d. for the half-year ending June 30 last. In regard to the various negotiations which they had had with the local authorities, the completion of the sale of that part of their undertaking in the borough of Wednesbury still remained in abeyance; the sale to the Handsworth Urban District Council of the lines and depôt in Handsworth had been completed at the price mentioned last year; while negotiations were still pending with the Corporation of Dudley regarding the purchase by them of that part of the undertaking in that borough. All these negotiations would be greatly helped by the lessee company holding such a large proportion of the shares, for all interests would be in harmony, and it would practically be a dual control. He proposed the adoption of the report and accounts, and the motion was carried.

British Westinghouse Electric and Manufacturing Company, Limited.—At the annual meeting, which was held on December 6, Mr. W. I. Buchanan, who presided, said he had received many inquiries from shareholders as to why it should be necessary to do so large a business to secure so small a profit. The fact was that the works had not been laid down for the present, but for the future, and great expenditure had been made in perfecting the establishment. Then, to prepare for the great business they hoped to secure an expert and expensive staff, and selling organisation had had to be brought into being. They had founded the works, too, on the belief that a great change in methods of traction was at hand, and no one could doubt that a radical change in methods of transportation in the country within certain wide limits, would certainly take place, but whether within the next two or three or five years he would not hazard an opinion. Preparing to meet those requirements had been costly. That had accounted for much of the comparatively heavy expenses. As to whether their selling prices were too low, he would point out that having erected those works and assembled that staff to meet future requirements it became necessary to find work for them to do, and it became economical to accept lower prices than could be desired in order to keep the works employed. Another competitive element which counted for much more was the competition met with in England from manufacturers abroad. In his opinion it was not so much the number of orders secured by Continental firms as the influence that their competition had upon the whole range of prices quoted by home manufacturers. His idea of meeting the situation was to do everything to assure economical working, and then to go ahead and secure all possible work at the best obtainable prices. The equipment of such an undertaking as theirs was a difficult task. So far as he knew there was no foundation for the rumour that Messrs. Dick, Kerr and Company were securing the control of the business. He wished to say, in reply to those who criticised the amount of capital sunk in the business, that they were, as a fact, actually short of working capital, and would probably have to raise more. The report was adopted.

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TRAMWAY AND LIGHT RAILWAY NOTES.

BARKING.—The District Council are making an important extension of the electric tramway system which will link up, through Barking, the tramways of East Ham and those of the Ilford District Council. The constructural powers for these tramways were obtained by an order issued in 1902, but the work has been delayed because it was necessary first to build a bridge over the Roding, widen another over Loxford Water, and make extensive widenings in order to lay down double lines of rails. A new bridge over the London, Tilbury, and Southend Railway, at Barking, has yet to be built to take the place of the present level crossing, but this will only be a matter of a few months, and will not stop the linking, as the trams, until the bridge is finished, will run up to each side of the level crossing. When completed, the Barking tramways will go a long way towards joining up the main suburban systems, making transit from place to place quick and easy.

BELFAST.—On the afternoon of December 31 Mr. J. Barbour Glenn, secretary of the Belfast Street Tramways Company, entertained the Lord Mayor of Belfast and the members of the Tramways Committee to luncheon in the Grand Central Hotel, on the occasion of the Company formally handing over the tramway undertaking to the Corporation. Mr. Glenn oc upied the chair, and several members of the Corporation were present. After speeches by the Lord Mayor (Sir Otto Jaffe, J.P.) and the Town Clerk (Sir Samuel Black), the Chairman proposed "Success to the City of Belfast and the New Electric Undertaking," coupling with this toast the names of Sir Daniel Dixon, Bart. (chairman of the Tramways Committee), and Mr. Andrew Nance (general manager). On January 1 the cars were run for the first time under the auspices of the Corporation, and the work of electrification commences forthwith.—The City Council have intimated to Messrs. J. G. White and Company, that the various routes will be handed over to them, road by road, as they require them. The tender of Messrs. P. and W. MacLellan for old rails at 3s. 6½d. per yard has been accepted, this being the highest offer received.

BOURNEMOUTH.—The Corporation Tramways have been visited by the Peruvian Minister, who journeyed from London with Messrs. E. M. Lacey and Leigh (of the firm of Lacey, Sillar, and Leigh, consulting electrical engineers) to inspect the Bournemouth system for the purpose of report to the Peruvian Government, who are contemplating the electrification of main lines in Peru. His Excellency was received by the Mayor (Alderman J. E. Beale, J.P.), the chairman of the Tramways Committee (Alderman G. J. Lawson), the borough engineer (Mr. F. W. Lacey), the town clerk (Mr. G. W. Bailey), and the traffic manager (Mr. Barber), in whose company he made a tour of the town, travelling in the state car. He visited also the generating station and the car sheds, and was exceedingly gratified with what he saw. Bournemouth has the unique distinction of being the only town in the United Kingdom in which a combination of the conduit and overhead systems has been effected. The tramways were fully described in our issue of January 15, 1903.—The result of the arbitration proceedings between the Bournemouth Corporation and the Poole and District Electric Traction Company, in connection with the purchase by the Corporation of the Company's lines between Poole and Bournemouth, and the rights they possess in the Bournemouth and Christchurch districts, was made known on December 23. The umpire, Mr. Justice A. T. Lawrence, and the referees, Mr. W. Eve and Mr. R. Vigers, have fixed the price at £112,000, the Corporation to pay the costs of the arbitration. The Company's original claim amounted to about £450,000, whilst the Corporation's estimate was between £60,000 and £70,000.

BURTON AND ASHBY.—The light railway from Ashby-de-la-Zouch to Burton-on-Trent, for the running of which the Midland Railway Company obtained powers two years ago, is about to be commenced, and will be executed with all speed.

CROMARTY AND DINGWALL.—It is expected that operations in connection with the light railway, which is to connect Cromarty and other places in the Black Isle with the Highland Railway system, will be commenced early in spring. Sir Arthur Bignold, M.P., chairman of the Dingwall and Cromarty Light Railway Company, is understood to have made arrangements for the subscription of the balance of the unissued capital.

DARLINGTON.—The Corporation have adopted halfpenny fares on their tramway system.

DARTFORD.—The electric tramway scheme formed the subject of discussion at a special meeting of the Dartford Urban Council on December 20. The Council have hitherto been unable to find anyone prepared to lend the money to carry out the undertaking, but an offer has now been received, and the Council consequently met to decide whether the terms should be accepted, or the whole scheme deferred for two or three years in the hope that the money market would become cheaper. There were two alternative schemes of repayment. The lenders preferred that the Council should establish a sinking fund, and repay a portion of the money every five years. If this method of repayment were adopted they were prepared to advance the money at an interest of 4 per cent., but if the money were repaid in annual instalments an additional ⅛ would be required. The circumstances which led to the present position were the obtaining of the Order, and the agreement with Messrs. J. G. White and Co. to construct the tramway at the Council's expense; to take a lease of it for 5, 10, or 15 years, and to hand it over to the Council if it should have been a paying concern at the end of either of these periods. It was explained that the difference between the two methods of repayment was £5,000; the total repayment at 4 per cent. would be just under £200,000, and at 4⅛ per cent. £205,000. It was also mentioned that the repayments would be made by the contractors so long as they operated the tramways, and they had entered into two separate bonds, one for the construction of the line, and another for operating it. The vice-chairman, who presided, moved that the clerk be authorised to negotiate the loan upon either of the terms mentioned, but preferably at the rate of 4⅛ per cent. with repayments in annual instalments, subject to the sanction of the contractors and the Board of Trade granting the extension of the Order. This proposal was seconded, and on being put, the voting was equal, six members for and six against. The vice-chairman added his vote in favour of the motion, which was accordingly carried.

EAST HAM.—At the conclusion of the Electric Light and Tramway Committee meeting on December 6, a number of the members adjourned to the generating station to inspect the important extensions of the Corporation plant which have recently been made, and which are now completed. These consist of a new engine and generator, two 350 H.P. boilers, with condensers, pumps, water purifiers, etc.; the total estimated cost of the extensions being nearly £15,000. After inspection, the engine was started up by the chairman of the committee, Alderman J. Savage. The engine was built by Messrs. John Musgrave and Sons, Limited, of Bolton, and supplied by Dick, Kerr and Company, Limited. It is of the compound-vertical type, running at a speed of 100 revolutions per minute. This engine is by far the largest of its kind in the district, its full load capacity being 1,250 H.P. The total weight of the engine and generator is 145 tons, the fly-wheel alone weighing 41 tons, and the total weight of the revolving part is 70 tons. It is capable of generating sufficient current to supply 25,000 eight-candle-power lamps. The total machinery now installed in the station amounts to 3,100 H.P. The boilers are exactly the same as previously supplied by Messrs. Babcock and Wilcox, who are also the contractors for the condensers, steam-piping, pumps, and water purifiers. The members of the Committee, after inspecting the machinery, inspected the new canopy car, this being the first delivery of an order of six, which the Council hope to have running within a very short time.

EDINBURGH.—A report has been issued by the Board of Trade with reference to the explosion which took place on August 21, through a steam-pipe bursting in the Shrub Hill power-station of the Edinburgh and District Tramway Company. The report states that any danger there might have been to occupants of the boiler room of being scalded, or to the boilers themselves through blowing out the water and exposing the heating surfaces, was averted by the prompt manner in which the engineer, Mr. Webster, closed the steam connections, thereby incurring grave personal risk and injury. The pressure of steam on the boilers at the time of the explosion was 140 lb. The explosion was caused by the inability of the pipe to withstand the stress to which it was subjected at the time it ruptured. At the time of the explosion the fires were being forced to overcome a falling in the steam pressure after the main engines were started. The steam would therefore be superheated to such a temperature as would materially reduce the strength of copper.—The twenty-first annual general meeting of the Edinburgh Tramway Servants' Sick and Benefit Society was held on Dec. 26 in Picardy Place Hall, Edinburgh. Mr. J. E. Pitcairn, president, occupied the chair, and there were with him on the platform Mr. J. S. Adam, treasurer, and Dr. Thyne, medical officer to the society. The chairman explained the various items in the balance sheet. The receipts for the year have been £456 15s. 8d., and after meeting all charges there remains for division amongst the members the sum of £157 12s 11d., making the dividend for the year 9s. 3d per member. The membership of the society numbers 347, and the amount paid in sick and other special allowances during the year was £256 19s 3d. After the various office-bearers and trustees had been appointed, the meeting closed with a vote of thanks to the chairman for presiding.—It is understood that steps are being taken which, it is hoped, will result in a Provisional Order being introduced forthwith for the promotion of a tramway between Edinburgh and Queensferry. It is proposed, subject to the approval of the Corporation and the Edinburgh and District Tramways Company, that the route should be by Frederick Street and Comely Bank. If no arrangement could be come to under which the whole of the Frederick Street and Stockbridge line could be worked by electricity, the electric tramway would start from the present terminus at Comely Bank.

GLASGOW.—An audacious form of theft is reported from Glasgow. A man wearing the usual tramway uniform boarded an electric car and informed the conductor in charge that he had been sent to relieve him. Believing his story, the conductor handed over his tickets, punch and

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cash, and then left the car. On reporting himself at the depôt he learned that the story was a fabrication. The self-constituted conductor remained on the car for about ten minutes, and then vanished.

GOVAN.—An alarming tramcar collision occurred at Govan on December 16, resulting in four people being injured, one of them seriously. The cause of the collision was of an unusual kind. The driver of the moving car was overcome by sudden illness, and was observed to fall from his position on to the street, about 200 yards from the scene of the collision. At that time the car was proceeding rapidly, and on the conductor observing that it was uncontrolled he displayed admirable presence of mind. He promptly lowered the trolley-pole from the wire, thus cutting off the current and thereby reducing the speed. From the police account of the occurrence it seems that a car was standing still when another car came up at a fast rate from behind and dashed violently into it. The stationary car was knocked completely off the rails on to the footpath, and the rear platform was badly damaged.

HECKMONDWIKE.—After running a reduced number of cars in and out of Heckmondwike for about four months, owing to a disagreement with the Urban Council as to price to be paid for extra current required, the tramway company, on December 10, resumed a full service, including cars direct from the Market-place to Hightown and Batley, which places, during the dispute, could only be reached by changing cars at the boundary of the township. There have been several futile conferences between representatives of the two bodies, but it was stated that, as a result of a recent meeting in London, a satisfactory understanding had been arrived at.

HEYWOOD.—After being stopped for several months, the old steam cars have again commenced running at Heywood. Thirteen engines and cars have been purchased by the Heywood Corporation, who have received temporary running powers on the old lines from the Board of Trade. Next spring it is proposed to take the lines up and convert the system to electricity.

KINGSTON-ON-THAMES.—The London United Tramways Company have given notice to the Kingston Corporation of their intention to commence the construction of tramways on January 16. The routes to be taken in hand are from Kingston Bridge to the borough boundary at the top of Kingston Hill; along Richmond Road to the Ham boundary; along King's Road to its junction with Park Road; and from Clarence Street, along Eden Street, St. James' Road, Penrhyn Road, Surbiton Park Terrace, Surbiton Crescent, and thence along Claremont Road to Surbiton Station.

LAKE DISTRICT.—An innovation in connection with the railway facilities in the Lake District was made on the Furness Railway on December 26, when a railway motor-car commenced running on the Ulverston to Lakeside line. The car, which is about 61 feet long, accommodates 48 passengers, and is to be used for the winter traffic, as well as on special occasions in summer. A trailer, to accommodate 34 additional passengers, is to be attached to the car in case of necessity, and a speed of about 30 miles an hour will be run.

LEEDS.—The extension of the Leeds Corporation tramways from Kirkstall to Horsforth has been started. The undertaking, which is expected to be finished early in the summer, will, it is estimated, cost about £25,000.

LEICESTER.—The Leicester electric tramway system was practically completed on December 22, by the opening of the Fosse Road circular route. This is a matter for congratulation, seeing that the first route was only opened to traffic in May last. It is now possible to reach any part of the borough by electric car, and the number of passengers carried weekly is between 400,000 and 450,000.

LIVERPOOL.—On December 20 the conductor of one of the Liverpool electric trams found in his car a handbag which had been forgotten by a passenger. On the bag being opened at the terminus it was found to contain cheques aggregating in value £4,580. The owner, a well-known Liverpool merchant, turned up three days later and claimed the bag. He left without rewarding the conductor.

MIDDLESBROUGH.—J. Bates, a motor-man employed by the Imperial Tramway Company, displayed remarkable resource and courage at Middlesbrough on December 21. As he was driving a car down Linthorpe Road he observed a child standing on the track. He rang his bell, but the child took no heed of the warning, and as it was impossible to pull up the car in time, Bates, with admirable presence of mind, swung himself off the platform and moved the child off the track with his feet, swinging himself back to his post. Had it not been for the driver's readiness the child would inevitably have been run over.

NEWCASTLE.—The North Eastern Railway Company have withdrawn all first-class tickets and passes for their ordinary electric trains, and have notified travellers that first-class tickets will only be continued on the expresses in the event of their being patronised sufficiently to make them pay. If the one-class experiment is a success, it will probably be extended to all branches of the North Eastern Railway, only the main line expresses which are linked with other companies being excluded.—An accident occurred on December 28 on one of the branches of the North Eastern Railway which was recently electrified. A workman's train from Newcastle was approaching Point Pleasant Station when it ran into a horse and cart at a level crossing. The horse was thrown a considerable distance, snapping a number of signal wires. These sprang in all directions, and were cut up by the train passing over them. Pieces came in contact with the live rail, and instantly there was an alarming short circuit. Woodwork on the station platform was set on fire, and two of the carriages of the train became ignited. The motors of the train were damaged, and it could not move. A large staff of assistants at once got to work, and the flames were speedily extinguished, but not before much damage was done. The horse was instantly killed, and the line was blocked for two hours. The passengers proceeded to Howdon Station on foot, and joined another train there in order to get home. The driver of the horse escaped uninjured, and the cart, which was laden with clay, was overturned, but comparatively little damaged.—The Tramways Committee are considering the question of adopting covered in double-deck cars. A deputation consisting of the chairman (Alderman Baxter Ellis, the mayor), and the vice-chairman (Councillor J. H. Rodgers) will visit Glasgow and inspect the newest designs in top-covered cars.—A large number of applications have been received for the post of tramways manager, and a sub-committee has been appointed to deal with these.

PIETERMARITZBURG.—The municipal electric tramways were opened on November 2. The total cost of the system is said to be £105,000. When completed it will consist of 5½ miles of single track and three-quarters of a mile of double track, making a total length of 7 miles. There will be 4 miles of 95 lb. girder and 3 miles of Vignole track. The rolling stock will consist of 12 cars. The car shed is capable of holding 18 cars. The 6 cars at present on the track are double-deckers, with a seating capacity for 68 passengers. The new cars on order are of the latest pattern, with a seating capacity for about 40 persons. The larger cars will be reserved, as far as possible, after the new cars have arrived, for extraordinary traffic on holidays and special occasions.

ROCHESTER.—The first section of Rochester electric tramways system was inspected on December 21, by Major Pringle, of the Board of Trade, and the line was opened for public use on the following day. The new tramway brings Rochester into direct communication with Chatham.

SALFORD.—The Corporation have decided to increase their tramway rolling stock by 20 cars in order to cope with the additional lengths of tramways now nearing completion. The Electricity Committee reports that the laying down of the plant and equipment of the new station is completed.

SNOWDON.—Sir Douglas Fox and Partners, and Messrs. Harper Brothers and Company, the consulting engineers to the North Wales Power and Traction Company, Limited, in a letter to the daily press, state that the apprehension of injury to the beautiful district through which the electrical railway will run is based upon complete misapprehension of the circumstances. Their instructions were so to lay out the line as entirely to preserve the natural features, and to keep the railway out of sight at the Swallow Falls, and at other points where it might in any way interfere with the landscape. These instructions had been carried out, and, in passing the Swallow Falls, the railway will be either in tunnel or in deep cutting, and will be quite invisible from the footpaths frequented by tourists. By adopting electric traction, not only are noise and smoke avoided, but it becomes possible to follow the natural gradients and contour of the country, and thus to avoid unsightly cuttings and embankments. In passing Llyn Gwynant the railway is so placed as to leave the view of the lake and of the Snowdon mountains quite uninterrupted. The line in question is the connecting link between Bettws-y-Coed, Beddgelert, Carnarvon, and Portmadoc, forming a system of some 50 miles of light railway, to be worked by electricity generated by water power from a lake in the Snowdon range. The company had already obtained powers for, and are engaged in constructing and equipping, the sections from Portmadoc through Aberglaslyn Pass to Beddgelert and Llyn Gwynant, and from Beddgelert to Dinas and Carnarvon, and the power-station is in a very forward condition. The proposal has met with the entire approval of the landowners through whose property the railway will pass, and of the county and district councils, who have obtained the insertion of ample clauses to protect the public interests.

SOUTHAMPTON.—The situation at Southampton is anomalous. The Tramways Committee have controlled the department for nearly five years without the aid of a general manager. Proposals to appoint a manager come up periodically, and the subject was again discussed at last month's meeting of the Town Council without definite result. The energy and devotion of the chairman, Alderman Dunsford, are unquestioned, but there is a feeling abroad that the hands of the Committee should be strengthened by the appointment of an experienced official. The tramways undertaking is doing none too well at present, and the absence of an executive head on whom to fix the responsibility is severely felt.

SOUTH SHIELDS.—The Town Council, on December 13, decided to begin the construction of the permanent way of the electric tramways at the earliest possible date, and to erect a commodious car shed.

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PATENT LIST.

Specially abstracted for "The Tramway and Railway World" from the Official Journal of Patents.

∴ If the inventions have been communicated the names of the communicators are given below in italics.

APPLICATIONS.

Applications for Letters Patent have been filed as follows:

25,913 Method of dealing with road or rail surfaces particularly applicable to tramways—E. J. Christie.
25,939 Reversible dry seat for tramcars, etc.—J. E. Harris.
25,964 Construction of wheels for tramways, etc.—E. N. Henwood.
26,112 Dry seat for tramcars—J. Merrill.
26,222 Emergency slipper brake for tramcars—G. E. Cousins and F. B. Sykes.
26,251 Wind and weather shield for outside passengers—J. B. Johnston.
26,297 Process and apparatus for joining rails, etc.—H. Goldschmidt and F. Lange.
26,331 Lifeguard for electric cars—F. Darnton.
26,358 Permanent way for railways and tramways—L. E. Schlüssel.
26,470 Signal apparatus for tramways—R. J. J. Swan.
26,603 Apparatus for forming devices for suspending trolley wires—I. E. Winslow.
26,618 Appliances for shifting tramway points—A. Taylor, junior.
26,957 Signalling on electric tramways and railways—C. H. Pym and E. J. Witcombe.
27,028 Flexible continuous cover for plough-way of electric conduit system and apparatus on cars for manipulating said cover—T. T. Dewhirst and B. Biggs.
27,039 Exposed seats for tramcars, etc.—J. Riley.
27,051 Point apparatus for tramways—A. W. Kiddie.
27,114 Gear for moving tramway points—A. C. Virgin.
27,135 Hangers for trolley wires—H. Heap, J. Bailey, T. Brierley, R. Billington, A. Richardson, J. Haydock, and T. S. Jones.
27,209 System of electrical distribution for railways—J. H. Hallberg.
27,325 Machines for grinding tramway rails—H. Mattinson.
27,467 Method of working traffic on single lines of railway or tramway—W. T. Lucy.
27,550 Tram ticket or railway ticket holder—C. M. P. H. Triscott.
27,783 Means for supporting and connecting trolley wires—T. Dawson.
28,049 Railway and tramway tyres—J. E. Fletcher.
28,090 Combined bolts and yokes used with tramway and railway rails—Bayliss, Jones, and Bayliss, Limited, and R. Howarth.
28,095 Anchors for tramway rails—J. Kirkland.
28,175 Electric tramways and railways—F. W. Baynes.
28,177 Means for operating tramway and railway points—W. Taylor.
28,208 Trolley head—J. Burns and J. D. Allan.
28,212 Trolley poles—F. G. Squirrell.
28,486 Tram and vehicle tracks—T. H. Gibbon.
28,512 Railway and tramway rails—D. W. Cuthbert
28,525 Trolley standards—M. B. Mountain and G. M. Gibson.
28,677 Safety device for electric railways—F. Owen.
28,757 Affixing rail bonds to rails—W. H. Cole.
28,922 Protecting device for tramcars—F. Esemann.
28,945 Means for signalling on railways and tramways—J. W. Lawson.
28,979 Combined rail cleaner and sprinkler for tramways and light railways—H. Conradi.
29,001 Electric railway conduit systems—J. Van Aerschot.
29,004 Electric railways and tramways—C. Mackintosh.
29,063 Insulators for overhead electric conductors—E. Giraud.
29,064 Safety devices for overhead electric conductors—E. Giraud.
29,070 Cleaning device for tramway rails—T. Handley.
29,250 Motor propelled tramway and other vehicles—A. Goodwin.
29,449 Girder rails, fish-plates, joints, and supports—J. Hart.
29,516 Automatic circuit breaker for overhead tramway systems—H. G. Turnell.
29,533 Cable traction systems—G. W. Sanders.
29,644 Obstruction removers for tramcars—H. Rebbitt.

SPECIFICATIONS PUBLISHED.

1903.

25,316 Wheels for railways and tramways—Ellis and Ashworth.
27,069 Means for operating points on electric tramways—Cardell.
24,847 Electro-mechanical automatic switches for surface contacts for electric tramways and railways, and for automatic signalling—M. G. Waggott, M. Rosenberg, and W. Smyth.
25,854 Suspenders for overhead electric conductors—British Thomson-Houston Company (*General Electric Company*).
25,970 Current collector for stud-contact systems of electric traction—Griffiths and Bedell.
26,124 Apparatus for operating electric railway and tramway points—Stewart, Turner, and Dixon.
26,513 Canopy trolley standard for electric tramcars—de Macedo.
18,980 Electric signalling on railways and tramways—Tunstall.
27,038 Sanding apparatus for electric cars—Liddle.

1904.

351 Safety device for vehicles propelled electrically on the stud-contact system—Griffiths and Bedell.
15,808 Automatic registering bell-punch—Barnes.
21,648 Trolley heads for electric traction—James and West.
20,945 Permanent way of railways and tramways—Ervin.
1,403 Railway and tramway frogs or crossings—Hadfield.
4,690 Mono-rail traction—Faroux.
18,561 Live-rail protections for electric railways—Linkleter.
22,703 Apparatus for operating tramway and railway points and signals—Lewis.
772 Points for railways and tramways—Smith.
1,624 Device for preventing accidents from broken trolley wires—Mudie.
1,980 Binding fare tickets in packets and staples therefor—Black.
1,981 Securing packets of fare-tickets by staples—Black.
2,243 Trolleys—Thomson.
2,397 Trolley wheels—Carnegie and Beevers.
2,449 Emergency brakes for electrically-propelled vehicles—British Thomson-Houston Company (*General Electric Company*).
2,558 Device for automatically switching off electric current immediately trolley wire breaks—Payne and Poupart.
23,050 Electric railways—Gill.
2,768 Joints and construction and setting of tramway rails—Shepherd.
6,929 Life-guards for tramcars—Nuttall and Pearson.
18,988 Safety apparatus for tramcars—Stanley and Anger.
23,753 Transfer tickets for use on tramcars—Jack.
23,999 Drilling cramp for tramway and railway rails—Kemmish.
24,001 Ticket punching, indicating, and registering machines—Maxwell.

TENDERS INVITED.

JOHANNESBURG MUNICIPALITY.

TRAMCARS, WATER CARS, CRANE, ETC.

The Municipal Council of Johannesburg is prepared to receive Tenders for:

100 electric tramcars,
3 electric water cars,
1 five-ton travelling crane,
1 electric car traverser, and
various workshop tools,

including erection at Johannesburg to Specification No. 10 of their Consulting Engineers, Messrs. Mordey and Dawbarn, 82, Victoria Street, London, S.W.

Copies of the specification may be seen on and after January 7 at the Council Offices, Johannesburg, and at the Consulting Engineers' Offices in London, and may be obtained on payment of five guineas, which will be returned on receipt of a *bona fide* tender. Duplicate copies of the specification may be bought for ten shilliugs each (not returnable).

Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria Street, London, S.W., and must be received by them not later than March 6, 1905.

The lowest or any tender will not necessarily be accepted, and the Council will not be responsible for any expenses incurred in tendering.

R. FEETHAM,
Johannesburg. Town Clerk.

BOROUGH OF DOVER.

TRAMWAY CONSTRUCTION.

The Town Council invite Tenders for the construction of about 1¼ miles of double line of light railway to River, commencing by a junction with the Dover Corporation Tramways at Buckland, including the supplying and laying of steel girder rails, fish plates, tie bars, etc., Guernsey granite setts and Jarrah wood paving blocks on a bed of cement concrete, also creosoted deal sleepers, etc., steel poles and overhead equipment, copper bonds, etc., in one contract.

A form of tender, specification, and bill of quantities may be obtained on payment of five guineas (returnable on receipt of a *bona fide* tender if the tender is not accepted), and conditions and plans inspected at the office of the Borough Engineer, Maison Dieu House, Dover, on and after January 3, 1905, during office hours. Tenders, endorsed "Tender for Light Railway," to be sent to me on or before noon on Monday, January 16, 1905. The Council do not bind themselves to accept the lowest or any tender.

WOLLASTON KNOCKER,
Town Clerk's Office, Castle Hill House, Town Clerk.
Dover, December 26, 1904.

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CHILLED IRON WHEELS

FOR

TRAMWAYS, RAILWAYS,

& MINES,

Supplied Loose or . . .
Accurately Fitted on Axles.

HYDRAULIC WHEEL PRESSES,

From 70 to 250 Tons Total Pressure.

CAR WHEEL GRINDING MACHINES

For Removing Flats and Trueing.

INCREASING LIFE OF WHEELS BY TREATING FLATS PROMPTLY.

— CASTING OPERATION. —

MILLER & CO.,

LIMITED,

LONDON ROAD FOUNDRY,

Telegraphic Address:
"MILLER, EDINBURGH."

EDINBURGH.

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TRAFFIC RETURNS.

TRAMWAY COMPANIES.

	1903. WEEKS ENDING Dec. 5.	Dec. 12.	Dec. 19.	Dec. 26.	1904. WEEKS ENDING Dec. 3.	Dec. 10.	Dec. 17.	Dec. 24.	AGGREGATE. Wks.	1904.	Increase or Dec.
	£	£	£	£	£	£	£	£		£	£
Aberdeen Corporation	1,066	1,070	1,076	1,174	1,098	1,085	1,063	1,475	30	42,834	+ 5,687
Airdrie	..	...	...	...	189	182	172	189	46	9,201	—
Barcelona	1,526	1,605	1,586	1,902	1,886	1,977	1,863	2,115	52	102,637	+ 14,474
Barnsley	152	146	154	214	147	153	147	151	51	8,565	− 604
Barrow	...	...	...	...	180	180	179	195	46	9,068	—
Belfast Street	2,200	2,345	2,389	2,919	2,320	2,279	2,322	2,643	26	67,015	− 2,160
Birmingham, City of	4,889	4,898	5,015	4,969	5,410	5,053	5,488	5,550	26	141,172	+ 7,278
Birmingham and Midland	881	801	811	909	911	990	983	1,014	51	45,010	+ 2,316
Blackpool and Fleetwood	182	159	153	226	182	157	152	182	23	21,098	+ 334
Blackpool Corporation	261	247	255	280	258	278	261	276	39	43,175	+ 5,966
Blackpool, St. Anne's, and Lytham	138	130	140	145	119	123	119	121	7	915	− 105
Bolton Corporation	1,567	1,660	1,610	1 884	1,719	1,626	1,678	1,626	39	71,599	+ 298
Bournemouth Corporation	734	770	805	873	706	762	793	857	38	42,179	+ 2,007
Bradford Corporation	3,314	3,301	3,366	4,055	3,607	3,585	3,729	...	35	169,463	+ 27,081
Bristol	4,274	4,309	4,425	5,265	4,175	4,534	4,506	5,076	26	131,872	+ 2,078
Burnley Corporation	774	746	769	1,017	933	...	987	982	25	26,472	+ 5,181
Burton-on-Trent Corporation	268	291	282	349	274	295	288	262	38½	13,272	—
Calcutta	Rs. 35,826	35,637	35,550	40,455	39,349	43,100	41,678	43,096	26	943,836	+102,311
Carlisle, City of	157	169	163	205	164	166	170	174	52	10,015	+ 185
Chatham and District	479	486	519	621	434	473	502	496	51	29,577	+ 1,966
Cork	357	385	389	482	384	431	376	446	51	23,765	− 2,516
Devonport	420	463	460	558	415	437	447	502	51	26,903	+ 3,158
Dover Corporation	166	176	169	177	153	172	180	192	39	8,834	− 164
Dublin and Lucan	89	84	81	96	87	100	90	105	25	3,120	+ 1
Dublin United	4,068	4,383	4,346	5,140	4,355	4,516	4,408	4,982	25	127, 04	− 2,338
Dudley—Stourbridge	733	715	728	806	707	734	734	675	51	43,827	+ 1,235
Dundee City	775	768	787	830	776	808	787	815	27	24,099	+ 241
East Ham U.D.C.	529	563	594	643	572	583	618	563	38	27,611	+ 1,429
Edinburgh and District	3,857	3,928	3,946	4,353	4,142	4,020	4,152	4,493	52	230,192	+ 9,363
Gateshead	835	843	856	1,060	837	873	857	897	51	46,332	+ 1,225
Glasgow Corporation	13,142	13,582	13,179	13,497	13 641	13,418	13,359	14,066	32	426,588	+ 20,866
Gravesend and Northfleet	188	197	203	294	165	188	176	176	51	12,606	+ 247
Greenock—Port Glasgow	438	493	431	497	465	527	447	514	51	29,232	+ 1,465
Harrow Road and Paddington	218	216	289	289	181	222	217	213	26	6,830	− 274
Hartlepool	234	235	241	301	226	242	232	242	51	14,821	+ 980
Hull Corporation	1,805	1,825	1,940	2,265	2,066	2,037	2,115	2,291	38	84,012	+ 10,457
Ilford Corporation	...	313	323	...	331	340	352	...	37½	17,275	+ 790
Ilkeston Corporation	110	114	120	138	93	93	87	120	39	5,415	—
Isle of Thanet	221	212	240	275	283	201	234	260	25	24,517	+ 1,848
Kidderminster	99	93	96	115	88	92	93	102	51	6,453	− 11
Lanarkshire	524	583	525	532	570	608	595	597	51	33,159	+ 19,315
Leeds Corporation	4,855	4,989	4,957	5,625	5,180	5,181	5,411	5,285	39	225,798	+ 12,497
Liverpool Corporation	9,317	9,526	9,753	10,838	9,691	9,707	10,121	10,473	52	537,171	14,280
London County Council	8,272	8,908	9,342	9,655	11,876	11,930	11,935	11,643	39½	488,717	+105,987
London General Omnibus	19,582	21,088	21,947	21,123	20,805	21,026	22,281	19,769	25	591,611	− 3,068
London Road Car	6,580	7,122	7,383	6,787	6,811	6,923	7,272	6,386	26	191,070	− 3,811
Manchester Corporation	10,565	10,737	11,040	10,401	11,094	11,400	11,677	11,003	38	467,465	+ 19,877
Merthyr	182	183	177	247	167	178	170	173	51	10,174	− 47
Middleton	235	224	238	286	223	255	247	224	51	16,334	+ 313
Newcastle-upon-Tyne	3,341	3,436	3,521	4,002	3,481	3,434	3,543	3,670	26	94,256	+ 2,952
North Metropolitan	10,140	11,075	11,280	11,769	10,433	10,603	11,023	10,660	26	299,816	− 11,630
Oldham—Ashton	494	474	498	567	445	483	484	413	51	27,685	− 1,267
Peterborough	105	103	109	168	98	101	105	103	51	7,499	− 315
Poole	199	213	208	264	194	198	203	224	51	15,251	− 24
Potteries	1,648	1,566	1,669	1,907	1,629	1,664	1,759	1,621	51	87,647	+ 5,827
Rossendale Valley	164	147	157	195	153	176	169	176	26	4,903	+ 384
Rothesay	33	40	33	41	33	33	29	30	51	6,945	− 28
Salford Corporation	3,464	3,741	3,716	4,084	3,773	3,749	3,817	3,710	38	157,186	+ 7,604
Sheerness	46	47	50	54	48	53	56	58	51	3,252	− 459
Sheffield Corporation	4,056	4,193	4,238	4,769	4,387	4,374	4,548	4,465	39	182,435	+ 3,509
Southampton Corporation	807	860	843	977	733	805	816	908	38	37,739	− 2,424
Southport	245	223	220	252	231	213	219	207	51	16,216	+ 391
South Staffordshire	950	934	955	1,059	619	640	625	621	51	33,642	− 8,717
Sunderland Corporation	1,046	988	1,072	1,208	1,082	1,058	1,116	...	37	47,804	+ 1,092
Swansea	482	450	462	599	444	429	459	451	51	27,339	+ 762
Taunton	43	46	45	60	37	42	39	43	51	2,736	− 331
Tynemouth	175	181	180	230	162	168	169	169	51	14,570	− 1,025
Tyneside Tramways and Tramroads	246	254	258	273	305	327	306	329	51	19,618	+ 3 300
Wallasey U.D. Council	569	572	595	638	614	620	676	633	33	29,076	+ 1,743
West Ham Corporation	...	...	...	...	930	1,023	1,014	1,012	43	40,778	—
Weston-super-Mare	26	22	20	19	23	26	25	25	51	6,239	+ 513
Wolverhampton District	327	321	323	369	321	343	335	331	51	19,729	− 93
Worcester	95	103	107	127	227	251	246	262	46	14,357	+ 7,214
Wrexham and District	110	102	105	156	83	84	83	92	51	5,500	− 1,059
Yorkshire (Woollen) District	435	443	435	628	463	500	488	460	51	29,438	+ 8,770

RAILWAY COMPANIES.

	1903. WEEKS ENDING Dec. 5.	Dec. 12.	Dec. 19.	Dec. 26.	1904. WEEKS ENDING Dec. 3.	Dec. 10.	Dec. 17.	Dec. 24.	AGGREGATE. Wks.	1904	Increase or Dec.
	£	£	£	£	£	£	£	£		£	£
Brecon and Merthyr	2,180	2,253	2,429	2,481	2,002	2,257	2,440	2,496	26	55,016	+ 1,646
Cambrian	4,717	5,118	4,483	4,879	4,617	5,178	4,288	5,094	25	188,166	+ 1,500
Central London	7,091	7,053	7,254	6,412	6,987	7,099	7,182	7,744	25	161,109	+ 1,077
City and South London	3,187	2,458	3,070	2,979	2,897	3,312	2,960	3,767	26	69,065	− 1,628
Furness	8,529	8,178	8,222	7,050	7,771	7,471	7,658	7,041	26	236,744	− 32,619
Great Central	61,419	60,885	60,155	55,816	64,031	62,897	59,910	60,609	26	1,712,900	+ 27,486
Great Eastern	99,300	98,100	99,900	116,600	99,400	99,100	99,200	115,100	25	2,805,000	+ 3,100
Great Northern	106,288	107,533	115,829	106,910	108,300	106,100	111,300	113,000	26	2,899,761	− 55,900
Great Western	203,700	211,400	226,100	220,000	214,000	212,500	223,600	249,600	25	6,028,000	+ 76,500
Hull and Barnsley	8,389	8,959	9,441	7,278	9,186	9,010	9,451	8,285	25	238,224	+ 4,502
Isle of Wight	496	379	475	604	469	418	389	572	26	13,569	+ 276
Ditto Central	582	531	665	594	541	588	614	625	26	18,399	+ 124
Lancashire and Yorkshire	94,385	96,188	98,734	97,558	94,205	97,501	97,207	89,962	25	2,753,055	+ 35,855
Liverpool Overhead	1,504	1,512	1,589	1,561	1,429	1,384	1,432	1,495	26	40,597	− 2,315
London, Brighton, and South Coast	54,888	52,687	56,087	62,949	55,491	51,707	52,717	59,259	26	1,721,018	+ 6,957
London and North-Western	261,000	257,000	269,000	247,000	256,000	245,000	254,000	265,000	25	7,039,000	− 129,000
London and South-Western	76,000	79,200	84,700	92,700	77,300	77,600	81,800	95,800	25	2,377,400	+ 15,000
London, Tilbury, and Southend	7,207	7,773	7,447	8,284	7,480	7,723	7,463	7,785	25	238,357	+ 4,157
Maryport and Carlisle	2,102	2,136	2,141	2,243	2,105	2,146	2,118	2,263	25	55,692	− 1,282
Mersey	1,471	1,374	1,426	2,737	1,609	1,555	1,648	2,138	25	37,872	+ 3,843
Metropolitan	16,880	17,482	17,460	18,180	16,939	17,814	17,383	18,463	25	432,348	+ 5,904
Ditto District	7,646	7,742	7,753	7,094	7,308	7,502	7,704	7,511	25	172,500	− 6,972
Midland	209,283	202,870	217,792	216,953	218,809	208,948	215,381	223,225	26	5,754,096	− 112,389
North-Eastern	167,063	160,872	168,474	187,419	155,718	161,187	158,799	175,833	25	4,546,716	− 66,432
North London	9,684	9,919	9,945	8,435	8,917	8,838	9,122	7,996	25	222,172	− 21,788
North Staffordshire	17,871	17,455	16,994	17,784	16,632	17,375	16,752	18,543	25	431,461	− 16,371
South-Eastern and Chatham	80,568	73,971	78,626	88,009	80,679	74,056	75,901	89,098	26	2,406,279	+ 12,251
Taff Vale and Penarth	20,038	17,237	19,134	16,528	19,109	17,362	17,918	18,077	25	453,515	− 16,287
Caledonian	76,493	76,208	77,938	78,770	77,578	76,348	76,695	81,922	21	1,799,015	+ 6,379
Glasgow and South-Western	30,771	29,836	30,974	30,646	30,419	29,085	28,697	30,423	21	739,311	− 11,484
Glasgow District Subway	1,423	1,428	1,404	1,429	1,394	1,379	1,384	1,347	21	25,991	− 1,454
Great North of Scotland	9,652	8,519	8,865	8,627	9,240	8,129	8,105	8,770	21	205,600	− 1,667
Highland	8,396	7,773	8,148	8,333	8,476	7,698	7,402	8,048	21	224,959	− 1,019
North British	81,814	82,558	84,291	82,837	84,969	79,954	79,600	83,970	21	1,936,771	+ 19,638
Belfast and County Down	2,261	2,386	2,243	2,338	2,279	2,370	2,367	2,509	25	77,317	− 901
Cork and Bandon	1,841	1,865	1,588	1,210	1,905	1,869	1,593	1,419	25	46,518	− 1,189
Dublin, Wicklow, and Wexford	4,792	4,054	2,931	4,012	5,194	4,131	2,995	4,128	25	140,108	+ 4,665
Great Northern of Ireland	17,130	16,577	16,727	19,161	17,253	15,964	16,755	18,522	25	504,650	− 2,402
Great Southern and Western	24,298	23,192	24,591	24,073	22,487	23,883	24,002	24,784	25	694,525	− 2,963
Midland Great Western	11,440	11,663	12,471	11,480	10,714	10,742	11,124	11,843	25	295,988	− 12,378

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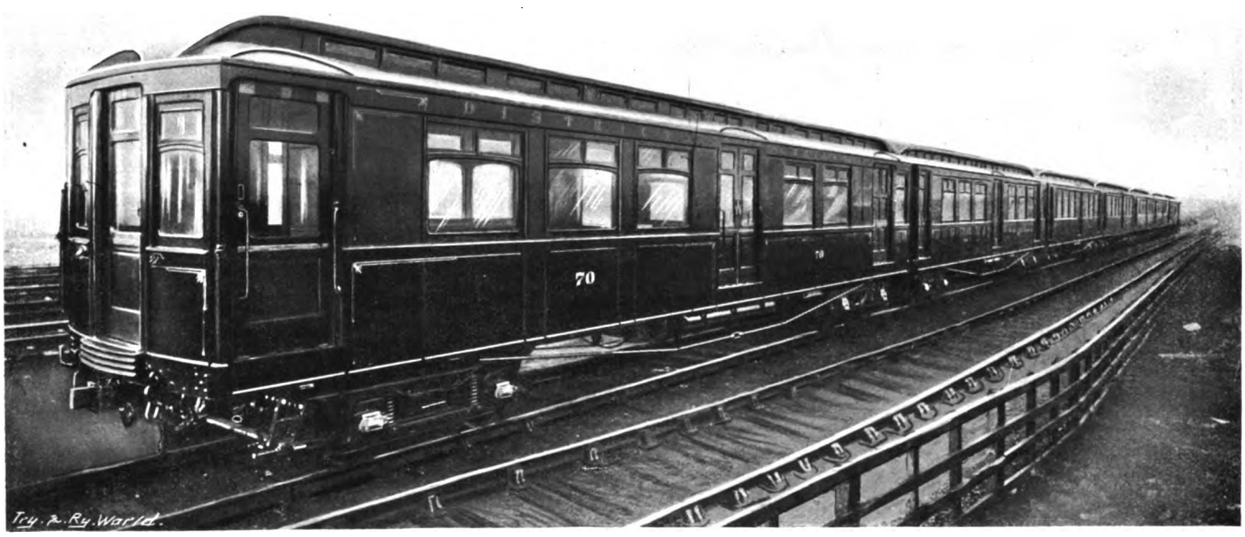
THE Tramway & Railway World
A REVIEW OF CURRENT PROGRESS IN ELECTRIC AND OTHER TRACTION

VOL. XVII. LONDON, FEBRUARY 9, 1905. VOL. XVII.

METROPOLITAN DISTRICT RAILWAY ELECTRIFICATION.

CHELSEA POWER-STATION OF THE UNDERGROUND ELECTRIC RAILWAYS COMPANY.

The enormous system of electric traction associated with the name of the Underground Electric Railways Company of London is now, through the commencement of the running of electric trains on the Metropolitan District Railway, about to enter its first stage of operation. The Baker Street and Waterloo Railway will shortly be opened for public service, and when the other underground electric lines belonging to the same group are completed, the whole, especially when taken in conjunction with the electrified part of the Metropolitan Railway, will form one of the greatest installations of electric traction on railways which the world has yet seen.



District Railway Electric Train.

At the present time we propose to confine our attention to the Metropolitan District Railway and to the great power-station which has been erected at Lots Road, Chelsea, by the Underground Electric Railways Company of London for the purpose of supplying energy to the District Railway and to the associated lines. It will be necessary, however, to make some brief reference to these other lines in order that the importance of the power-station may be understood. A comprehensive article, with a map, referring to the various railways which will be fed from Lots Road, appeared in our issue of January 15, 1903—an article which ever since appears to have been a rich quarry for all sorts of people desiring information on the subject. The situation has, however, somewhat changed in the course of two years, and it is desirable to give a *resumé* of the main facts and bring them down to date. As a preliminary to that, however, it is necessary to refer to the development of the Metropolitan District Railway, with which we are here especially concerned.

In an article published in this journal of July 14, 1904, we gave a description of the system of the Metropolitan Railway, and more particularly of the part of it which was then being electrified, while incidentally a good deal of reference was made to the Metropolitan District Railway in view of the fact that the Inner Circle Railway is partly owned by the one company and partly by the other. The map published with the article showed the respective

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lines of the two Companies. We now present a third and more comprehensive and detailed map, based on one recently issued by the Underground Electric Railways Company, which shows the present position as regards the lines of the two Companies which have hitherto been worked by steam locomotives, as regards the "tube" railways associated with the scheme for the District Railway Company, and as regards the London United Tramways. In the article on the Metropolitan Railway it was stated that the total length of route of that Company which was being changed from steam to electricity was 26 miles, including about a mile and a half at the east end of the Inner Circle jointly owned with the District Railway Company. It now appears that this joint part has been electrically equipped by the Underground Electric Railways Company on behalf of the District Railway Company as well as of the Metropolitan Company. We therefore reduce the purely Metropolitan Railway part to 24½ miles, while the District Company's lines now electrified extend to 29½ miles including lines jointly owned, and to 41 miles including those (apart from the Metropolitan's part of the Inner Circle) over which the District Company have running powers. To statistics of mileage we shall subsequently return.

HISTORICAL.

The Metropolitan District Railway Company came into existence as an operating company when the first section of their lines was opened for traffic on December 24, 1868. This was an extension of the Metropolitan Company's line which ran from Paddington to South Kensington, and it was about 2¼ miles in length, terminating at Westminster. The next section was from Gloucester Road to West Brompton, nearly a mile in length, opened in April, 1869, while in May of the following year the railway was pushed eastward for 1⅜ miles, from Westminster to Blackfriars. This involved the payment of a large sum for liberty to run partly under the Victoria Embankment. On July 3, 1871, a half-mile extension was opened to the Mansion House station, bringing the railway into the heart of the city of London. February, 1872, saw the running of the first London and North Western Railway Company's train over the District Railway, the junction being effected by a short line from Addison Road, Kensington, to Earl's Court. This link is three-quarters of a mile in length, and by its use also trains of the Great Western Railway Company began in the August following to run over the District Railway.

The western extension of the District Railway began to come into operation in September, 1874, when the line from Earl's Court to Hammersmith, 1⅛ miles in length, was opened. Nearly three years later, namely, in June, 1877, the Hammersmith line was extended for half a mile to Ravenscourt Park station (then known as Shaftesbury Road), where a junction was made with the London and South Western Railway Company's Richmond line. Running powers had been arranged, and from this date District Railway trains ran between the City and Richmond, the added section from Ravenscourt Park to Richmond being about 4 miles in length. The District Company have ever since continued to use the short length of London and South Western line between Ravenscourt Park and Turnham Green, and it now forms part of their through route east and west. This route was developed by the opening in July, 1879, of an extension nearly three miles long from Turnham Green, through Acton, to Ealing. In March, 1880, a branch 1⅝ miles in length, from West Brompton to Putney Bridge was opened, and a month later the line, previously constructed, but not up to then worked, between Kensington High Street and Earl's Court (a distance of three-quarters of a mile) was brought into use. The railway between Mill Hill Park and Hounslow Town (4½ miles) was opened in May, 1883, by the Hounslow and Metropolitan Railway Company, and this line, which in July, 1884, was extended for a mile and a half further to Hounslow Barracks, has since been merged in the District Railway, having been purchased by the District Company in 1903 for the very small sum of £165,000.

In October, 1884, the City Lines and Extensions Railway, 2¼ miles in length, and jointly owned by the District and Metropolitan Companies, was opened for traffic. This line continued the District Railway eastwards from the Mansion House station to near Aldgate, where a junction was made with the Metropolitan Railway, and the Inner Circle was thus completed. From Aldgate a spur was sent out (forming part of the 2¼ miles) eastwards to Whitechapel, where a junction was formed with the East London Railway, which runs southward to New Cross, and over which the District Company, among other companies, have running powers.

The London and South Western Railway Company in June, 1889, completed their line from Putney Bridge to Wimbledon, a distance of about four miles, and the District Company then began to exercise running powers over it. There were no further developments of the system till June, 1902, when the Whitechapel and Bow Railway, jointly owned by the District and the London, Tilbury and Southend Railway Companies, was opened. It is two miles in length, and connects with the Tilbury and Southend Railway at Bromley-by-Bow. From its opening, District Railway trains began running to and from East Ham, thus giving a through route between the extreme east and west ends of the metropolitan area. The distance from Bromley to East Ham is almost three miles. On June 22, 1903, an extension railway from near Mill Hill Park to South Harrow, a distance of six miles, came into use

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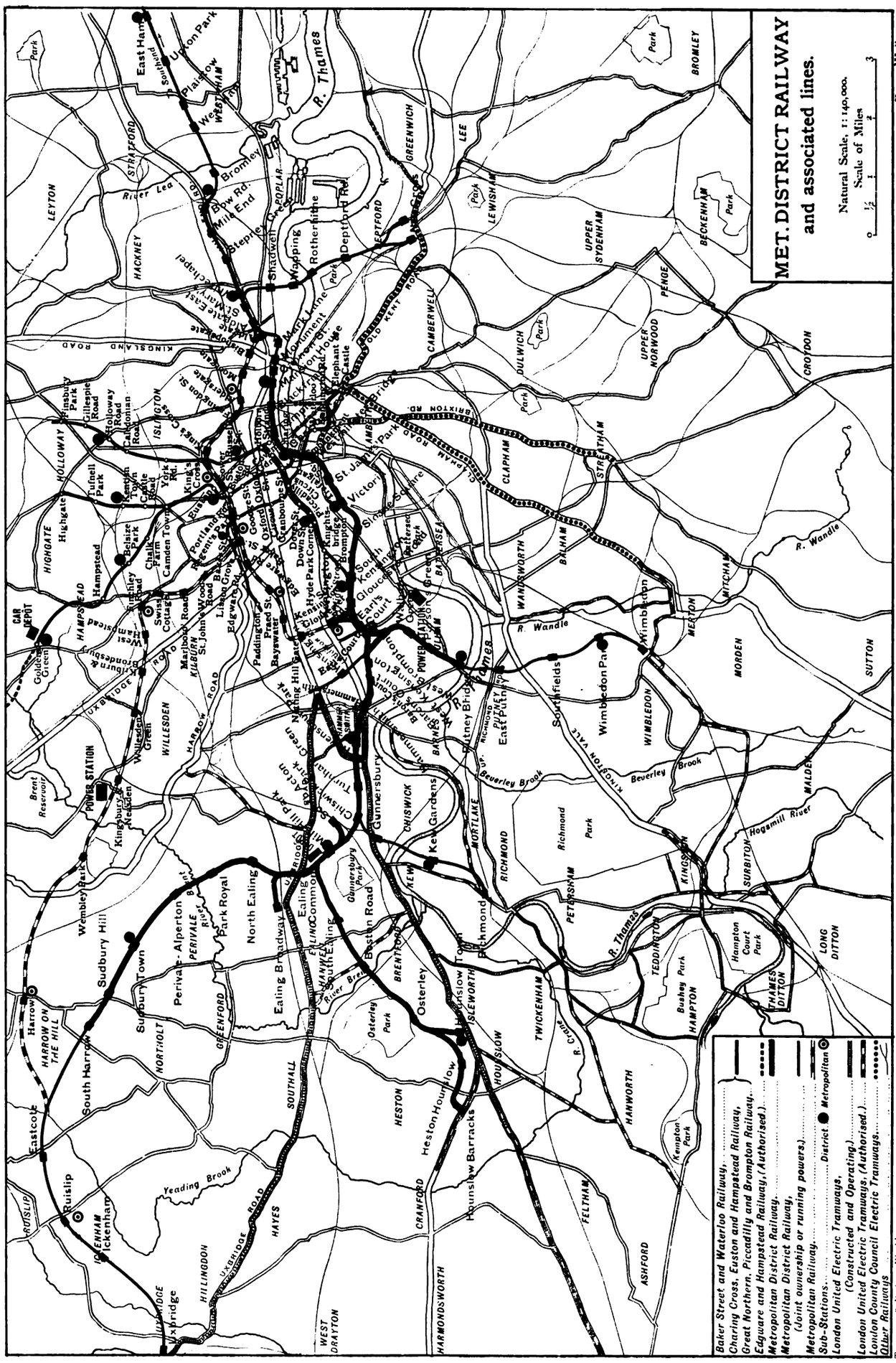

NOTE.—The line from Harrow to Uxbridge is owned and electrically equipped by the Metropolitan Company, but the District Company have running powers over the part in red.

for the purpose of experimental electric train running. It had been built for some time, but had not been opened for traffic, and it was now electrically equipped, and experimental trains were run upon it by energy from a temporary power-station. Subsequently it was opened for public service.

All sections which have been mentioned may be clearly traced on the accompanying map, and they have all been equipped for electric traction, with the exception of the East London Railway, where arrangements for making the change have not yet been carried out owing to the fact that quite a number of different railway companies run over this line. The electrification has also been carried along the Tilbury Railway for about a mile and a half past East Ham to Barking. Readers desirous of tracing the corresponding development of the Metropolitan Railway Company's system are referred to the article on that railway published in our issue of July 14, 1904.

Speaking generally, the more central parts of the District Railway are underground, while the suburban portions are in the open. These central portions were enormously expensive, owing to the great cost of land, and the figure (something like a million sterling per mile of route) reached in the City practically put an end to steam railway construction in such a locality. As readers are aware, however, the tunnels, though they have been grimy and suffocating owing to the use of steam engines, are large and roomy and close to the surface of the ground. In this respect the railway possesses a material advantage over "tube" lines, which ought speedily to show itself when the air in the tunnels is no longer polluted by steam locomotives. Double track is, of course, used over the entire system, while there is a considerable additional track length of sidings and cross-overs.

It is not surprising that the railway company owning lines which were so expensive have not been very prosperous from the point of view of dividend-earning, even though they have enjoyed a very large passenger business. At the time of writing the report of the directors for the half-year ended December 31 last has not been issued, but we may take as a sample, to show the position of the Company on the eve of beginning electric traction, the report for the half-year ended June 30, 1904. In that period the receipts from passengers were £198,865, and the total receipts £212,771. The number of passengers was 25,572,539, and there were no fewer than 18,259 season ticket holders. The working expenses came to £115,156, so that the balance was £97,615. More than the whole of this was absorbed by rent charges, debenture interest, and so forth, but credit rents and interest were sufficient to leave a balance available for dividend of £12,754. This was used up to pay a dividend at the rate of 2 per cent. per annum on the 4 per cent. guaranteed stock. The total dividend deficiency on that stock was £105,977. The other stocks of the Company, preference and ordinary, have not looked for dividends, but of course it is hoped that with the adoption of electric traction better things are in store.

At June 30 last the capital issued was £8,324,964 of stock, and £2,438,825 of debenture stock, a total of £10,763,789. The capital expenditure for the half year was £192,504, nearly all of which was for expense connected with the electrifying of the system. The total capital expenditure stood at £9,880,501. Allowing for the fact that some short lengths of the railway are jointly owned, it may be taken roughly that the capital liability on the railway absolutely owned by the Company is about £500,000 per mile.

The following table, showing at intervals of five years the number of passengers and the passenger receipts, indicates the growth of the traffic since the railway was opened to the Mansion House in 1871. We also give the figures for each year in recent times. The numbers of passengers do not include the journeys made by holders of season tickets, but the receipts include the money obtained for such tickets. The number of season ticket holders has of late years very much increased till it has reached over 18,000, and the revenue therefrom averages over £2 per ticket per annum.

Year ended.	Number of Passengers.	Passenger Receipts.
		£
June, 1872..	18,664,323	170,423
,, 1877	27,789,534	279,622
,, 1882..	31,575,298	360,380
,, 1887..	40,058,405	414,164
,, 1892..	38,592,257	406,277
,, 1897..	41,304,315	416,781
,, 1900..	40,704,636	411,017
,, 1901..	38,175,618	368,587
,, 1902.. .	39,105,441	357,139
,, 1903..	46,675,249	368,744
,, 1904	49,963,505	375,515

The year ended June, 1900, was the last before the opening of the Central London Railway, and the effect of the competition of that line, which was opened in July, 1900, is at once visible in the falling off in passengers and receipts for the year ended June, 1901. The District Company met this by reducing their fares, latterly very materially, and the result is observable in the great increase in passengers, but the receipts have not gone up to the old figures.

THE ELECTRIC TRACTION SCHEME.

It was this competition by the Central London Railway which brought to a head the project for electrifying the District Railway. As far back as 1897 the company obtained Parliamentary powers for working their railway electrically, and for constructing a deep-level electric railway under their present line from Earl's Court to the Mansion House. These powers were extended by an Act of 1900,

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which also authorised the erection of a generating station at Lots Road, Chelsea. Nothing effective was done to put the powers into execution, as the difficulties of obtaining the necessary capital were great. Electric driving and the uniform fare of twopence on the Central London Railway, coupled with the growing competition in the western suburbs of the rapidly spreading London United Tramways, soon made action imperative. Some experiments in running an electric train between Earl's Court and Kensington High Street were made in 1899, and both the Metropolitan and District Companies determined to electrify the Inner Circle Railway. Mr. C. T. Yerkes, of Chicago, was in negotiation in 1900 with Mr. R. W. Perks, M.P., with the object of acquiring the authorised Charing Cross, Euston, and Hampstead Railway, an electric "tube" line for which powers had been obtained. That concession was duly acquired, and Mr. Yerkes was induced to go into a scheme for electrifying the District Railway. He acquired a substantial holding in the District Company, and with the assistance of friends formed in July, 1901, the Metropolitan District Electric Traction Company, Limited, with a capital of a million sterling, which was privately subscribed. In the following month Mr. Perks became chairman of the District Company. Meanwhile the horizon of possibilities was extended by the Yerkes group of capitalists acquiring also the authorised Baker Street and Waterloo Railway (which was actually under construction), the Great Northern and Strand Railway, the Piccadilly and Brompton Railway, and afterwards the Edgware and Hampstead Railway. On April 9, 1902, the Underground Electric Railways Company of London, Limited, with a capital of five millions was registered, and it took over the Traction Company. Mr. Yerkes became chairman. It is needless now to repeat details on these matters, beyond stating that the new Company undertook to electrify the District Railway, taking payment for the most part in shares issued at a discount; to construct and equip the tube railways, guaranteeing 4 per cent. on the capital required for construction; and to erect the great power-station at Lots Road, Chelsea, from which it would supply current at a fixed rate of charge to all the railways. During the last two or three sessions of Parliament powers have been obtained for extending and connecting by exchange stations the various lines, and the whole system when complete should be of great advantage to London. Had Parliament acceded to the application to consolidate the four tube railway companies into one, the benefit would have been still greater, as a uniform fare would have been charged for any journey on the associated railways within London, though the passenger might have to change from one railway to another. Largely through the opposition of the London County Council, which opposes all schemes for London not promoted by itself, the benefit was not secured. The history need not be reviewed of the arbitration in the latter part of 1901 between the Metropolitan and District Companies as to what form of electric traction should be used on the Inner Circle. It was necessary to have uniformity, and the Board of Trade arbitrator, Mr. Alfred Lyttelton, now Secretary for the Colonies, decided in favour of the District Company's contention that the continuous current system (with three-phase alternating transmission) should be used, and not the Ganz alternating current system as proposed by the Metropolitan Company.

An additional electric line, called the Watford and Edgware Railway, was authorised by Parliament in the session of 1903. It will be a continuation of the Edgware and Hampstead Railway, and like that line, being in the country, will not be underground. Arrangements are being made for working this line also from the Chelsea power-station. The lengths of the various railways which will be supplied with energy from Lots Road now stand as follow: (The running powers of the District Railway mentioned in the table do not, of course, include the portion of the Inner Circle belonging to the Metropolitan Company, as that portion is fed from the Metropolitan Company's power-station at Neasden.)

	Miles.
District Railway and running powers	41
Baker Street and Waterloo Railway	5¾
Great Northern, Piccadilly, and Brompton Railway ..	7¾
Charing Cross, Euston, and Hampstead Railway ..	8
Edgware and Hampstead Railway	6
Watford and Edgware Railway	6¼
Total	74¼

It will be remembered that in connection with the great Parliamentary struggle of 1902 over new tube railway schemes, the Yerkes group of capitalists acquired a controlling interest in the London United Tramways, and that great system will work in harmony with the District Railway and the associated tube lines. The London United Company have, however, their own power-station at Chiswick.

FINANCIAL AND OTHER ARRANGEMENTS.

It only remains, before passing to the power-station, to indicate a few general arrangements which have been made. It has been publicly stated on several occasions that the tube railways to be constructed would cost about fifteen millions sterling, and that the Underground Electric Railways Company would find the money. This estimate was made before some of the extensions of the lines had been authorised, so that the figure may be exceeded. That the promise is being carried out is shown by the rapid progress of construction work on the tube railways, and by the statement made by Mr. Edgar Speyer, of Speyer Brothers, before the Royal Commission on London Traffic on June 3rd, 1904, that he and his associates had already

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subscribed twelve millions additional capital for the construction of the tube railways. In consideration of their organising the Underground Railways Company and finding much of the capital, Messrs. Speyer have the nomination of the majority of the directors for a period of ten years.

In the latter part of 1903 the Underground Electric Railways Company made an offer to holders of preference shares in the District Railway, namely, to guarantee a dividend on the 5 per cent. preference shares of 1 per cent. from January 1, 1903; 2 per cent. from January 1, 1904; 3 per cent. from January 1, 1905, to January 1, 1907; and 3½ per cent. thereafter in perpetuity.

According to a statement made by Mr. Perks at a meeting of the District Railway Company on December 17, 1903, the total stock issued to the Underground Railways Company in payment for the work of electrically equipping the District Railway is £1,050,000 of second preference stock and £985,000 of ordinary stock. At a subsequent meeting on February 11, 1904, he mentioned that the Underground Railways Company also took a proportion of debentures, the debentures being taken at par, and the preference and ordinary stocks at a large discount. The estimated actual cost of the electrical equipment of the District Railway was from £1,100,000 to £1,200,000.

The electrical equipment of the lines of the London and South Western Railway Company over which the District Railway Company run has been carried out by the Underground Railways Company under a contract with the South Western Company. Arrangements were also made whereby the Underground Railways Company equipped the eastern joint lines and the Tilbury Company's line as far as Barking, the whole matter being carried out as one job. Simultaneously a widening of the District Railway has been effected so as to provide four tracks from West Kensington to Hammersmith. The two additional tracks are for the Great Northern, Piccadilly and Brompton Railway which comes to the surface near the new Baron's Court station at West Kensington, and is

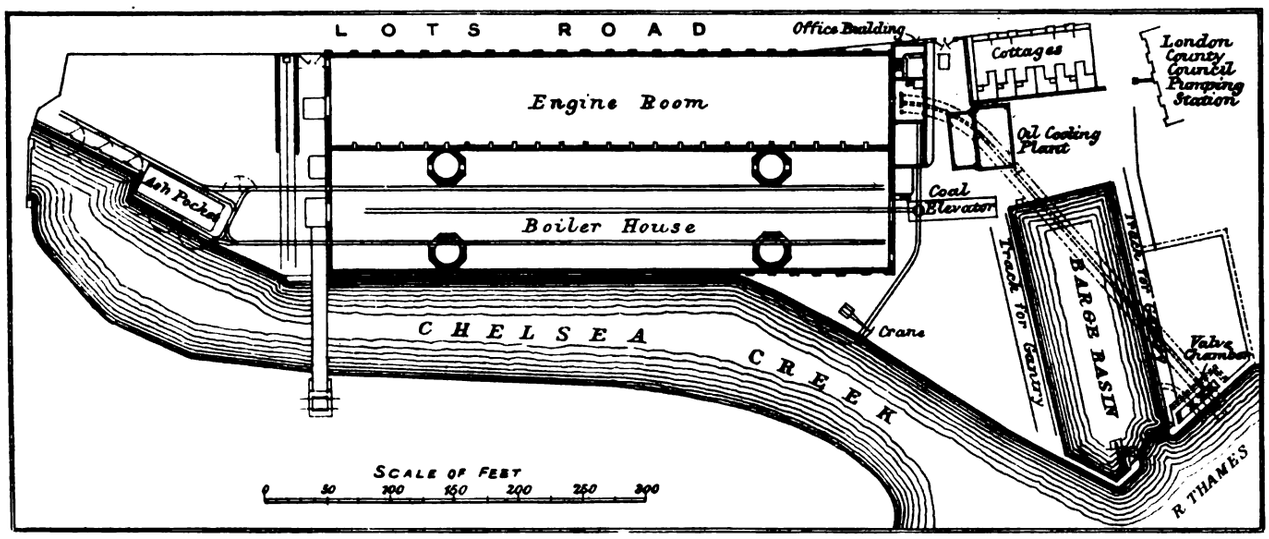

Fig. 1.—General Plan of Site and Buildings.

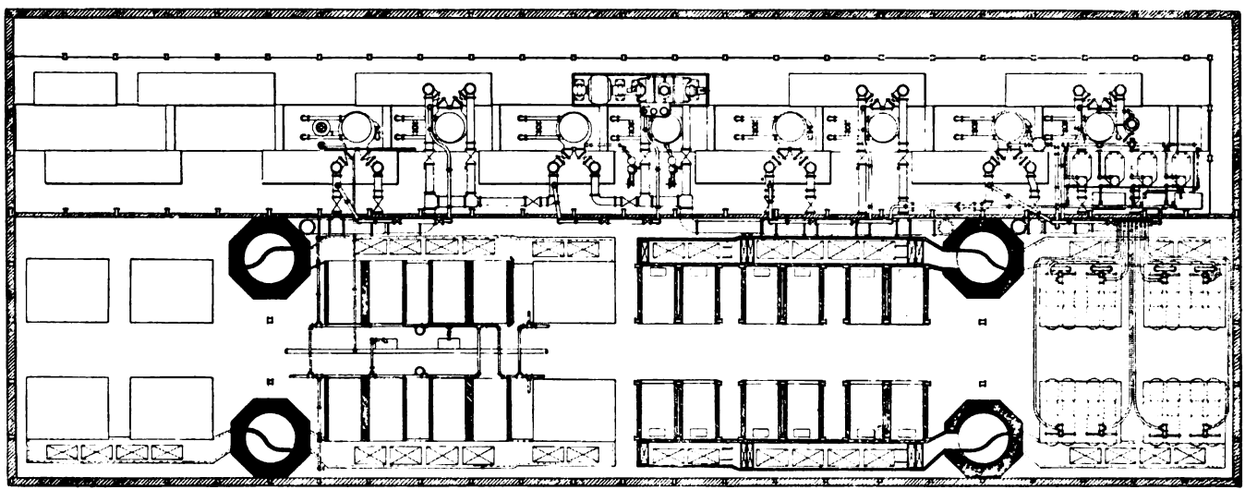

Fig. 2.—Outline Plan of Chelsea Power Station.

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continued in this way alongside the District line to Hammersmith. Under an agreement between the two Companies, the District Company will derive the whole of the benefit of the traffic on the new line between West Kensington and Hammersmith.

THE CHELSEA POWER-STATION.

The position of the site of this great station is shown on the map. An area of 3·67 acres is occupied; the water frontage on the Thames and on Chelsea Creek is 1,100 ft. long; the frontage to Lots Road measures 824 ft. The general arrangement may be gathered from the plan (Fig. 1). The main building is 453 ft. 6 in. long by 175 ft. broad, and is 140 ft. high. The office building at the east end measures 81 ft. by 25 ft., and has three floors. The main building consists of a steel framework weighing about 6,000 tons, clothed with terra cotta and brick, and roofed with concrete and glass. There are four chimneys, each 275 ft. high. The water-tube boilers are 64 in number, and are arranged on two floors, with coal bunkers above. They supply steam to eight turbo-generators of 5,500 KW. each, three-phase current at a pressure of 11,000 volts and a frequency of 33⅓ periods being produced. From elaborate switch gear the current is sent out through underground cables to the District Railway at Earl's Court, and thence the cables run to the various sub-stations. The whole building and its appliances are of an almost unprecedented magnitude, and to any one accustomed to small power-stations the effect at first sight must be stupendous. We propose to deal seriatim with the more important features (premising that many details must be omitted). In order to do this, the building must first be described, and then, starting with the coal-handling plant, the various sections of the installation can be taken in natural order.

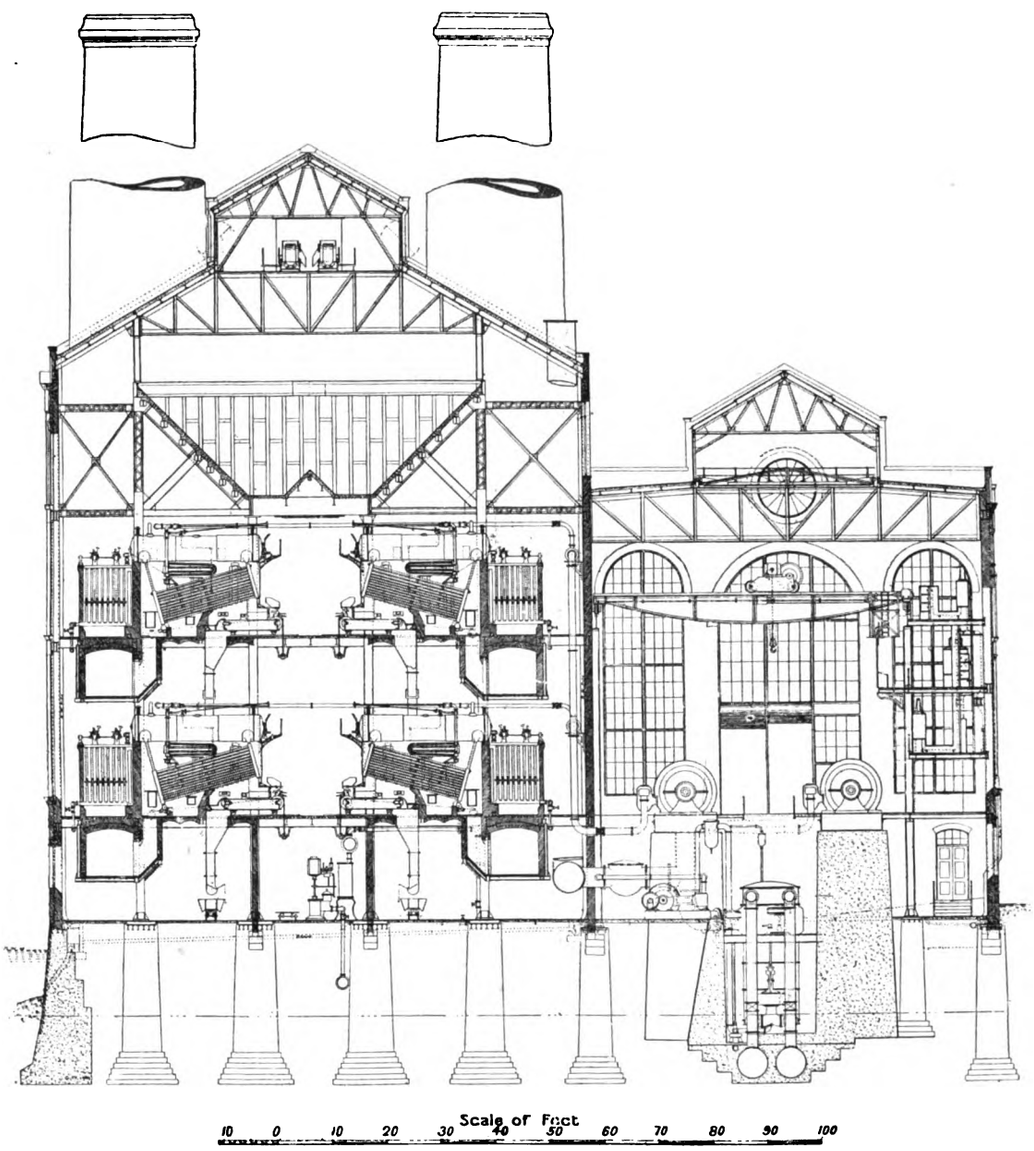

Fig. 3.—Cross Section of Chelsea Power Station.

The position of the station is a very favourable one. Coal is brought up the Thames in barges and delivered direct to the coal conveyors, and

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from the river also an unlimited amount of condensing water is obtained. The West London Extension Railway has sidings on the opposite bank of Chelsea Creek, and coal can also be brought in that way. Building material and machinery were readily conveyed to the site by river, and lifted and handled by a powerful crane. It will be noted from the plan of the building (Fig. 2) that space is allowed for the accommodation of two more generating sets in the station, and also for another of half-size (2,700 KW.), so that the total equipment will ultimately include 80 boilers and 11 turbo-generators, aggregating 57,700 KW., or nearly 80,000 H.P.

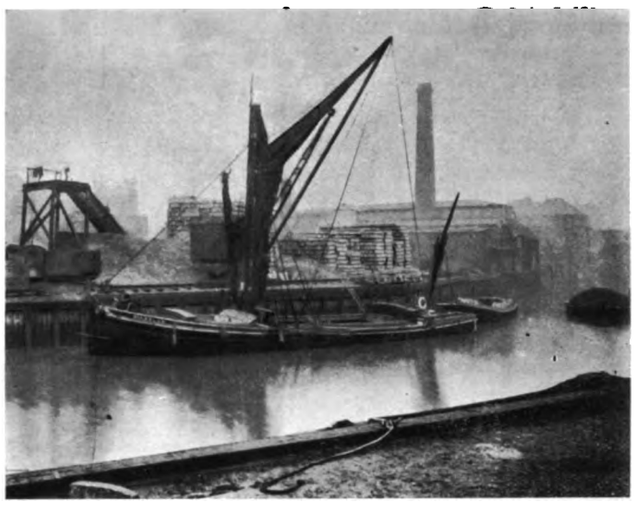

Fig. 4. View of Site at Chelsea before work began.

FOUNDATIONS.

Owing to the nature and situation of the site the foundation work for the building is of more than ordinary interest. It formed the subject of a separate contract, let to Messrs. Perry and Company, Bow, London, who have great experience in foundation and other work requiring excavation and strong underground construction. The contract also included other items, but these will be referred to later. Before the ground was acquired by the Underground Electric Railways Company it was occupied by dust destructor and other works belonging to a company. The appearance of the place before much was done by the Underground Railways Company may be gathered from Fig. 4, which is a view taken on June 1, 1902. Work was commenced on a chimney foundation in March, 1902, but all the area on which the building stands did not come into the possession of the Underground Railways Company till November, 1903. The space at the disposal of the contractors was necessarily limited, and the fact that the whole site could not be given up at once handicapped the work.

The foundations were carried down through made ground, gravel, and sand into the London clay, the total depth being 30 ft. below basement floor level, or about 35 ft. below the level of Lots Road. The stanchions carrying the steel frame of the building are about 19 ft. apart, and the foundation for each stanchion is independent and consists of a tapering column of concrete on a stepped base of the same material. This arrangement is shown in Figs. 3 and 5. Considerable difficulty was experienced with water in the stanchion foundations on the Chelsea Creek side of the site, and it was found necessary to put a steam pump in every hole to keep down the water which would not drain through from one hole to the next.

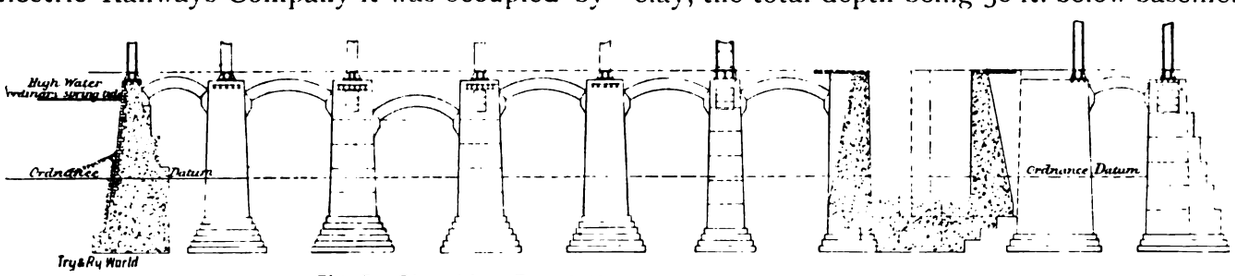

Fig. 5.- Stanchion Foundations for Chelsea Power Station.

A stage about 300 ft. long was constructed on the old wharf wall, overhanging the barges in the creek. This stage was sufficiently high to allow empty barges to come under it, and it projected over the creek as far as the centre of the barges. The wagons of excavated material were drawn up an incline on to this stage by a steam winding engine and tipped direct into the barges, no trimming being required.

The turbine and generator foundations, which run through the entire length of the engine-room building, are about 60 ft. wide, and they were carried down to the same depth as the stanchion foundations. They had of course to be carried

Fig. 6.—Foundation Work at Chelsea Station.

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up to the first floor level. Large masses of concrete, which had formed old engine foundations on the site, were encountered during the excavation for the new work. This old concrete, in places 12 ft. thick, was blasted out, the holes for the charges being drilled with pneumatic rock drills supplied with compressed air from an installation specially put in for the works by the Underground Electric Railways Company. The foundations for the four chimneys were constructed at the same time.

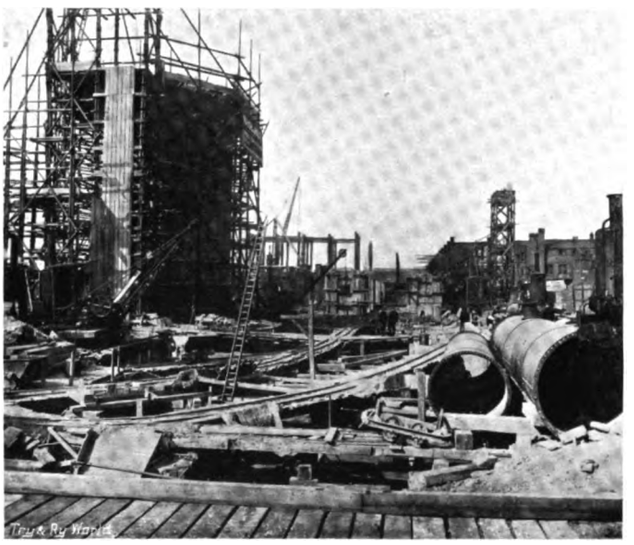

Fig. 7.—Foundation Work at Chelsea Station.

The wharf wall runs the whole length of the site on the margin next Chelsea Creek, and it is 980 ft. long and 30 ft. high. The wall is composed of Portland cement concrete, faced with specially made blue Staffordshire blocks. The blocks forming the header courses are 12 in. by 6 in. by 6 in., and the stretchers 18 in. by 6 in. by 6 in. In order to build this wall a dam was constructed along the whole water front of the site, and it was divided into sections which were driven and completed as opportunity occurred. The dam was what is known as a single-pile dam, and was constructed of full timber piles, driven down to about six feet below the level of the bottom of the new wall, with three pairs of full timber walings, or horizontal beams, bolted to them. As each section of the dam was made water-tight, it was pumped out by an 8 in. centrifugal pump. The old wall was then pulled down and the new one built. The piles had to be driven through a layer of running sand before the London clay was reached, and in several cases it was found, on excavating the interior of the dam, that piles had "umbrelled up", that is to say the resistance to driving was so great that the iron pile shoe was forced right up into the pile, splitting it and turning the end up on all sides. Of course no sign of this was visible from the surface, and it was only discovered when the excavation was in progress. As soon as a bad pile of this kind was detected, runners were pitched round the danger spot and driven down as the excavator proceeded. In one or two cases, however, before the broken part of the pile had been reached, the pressure of

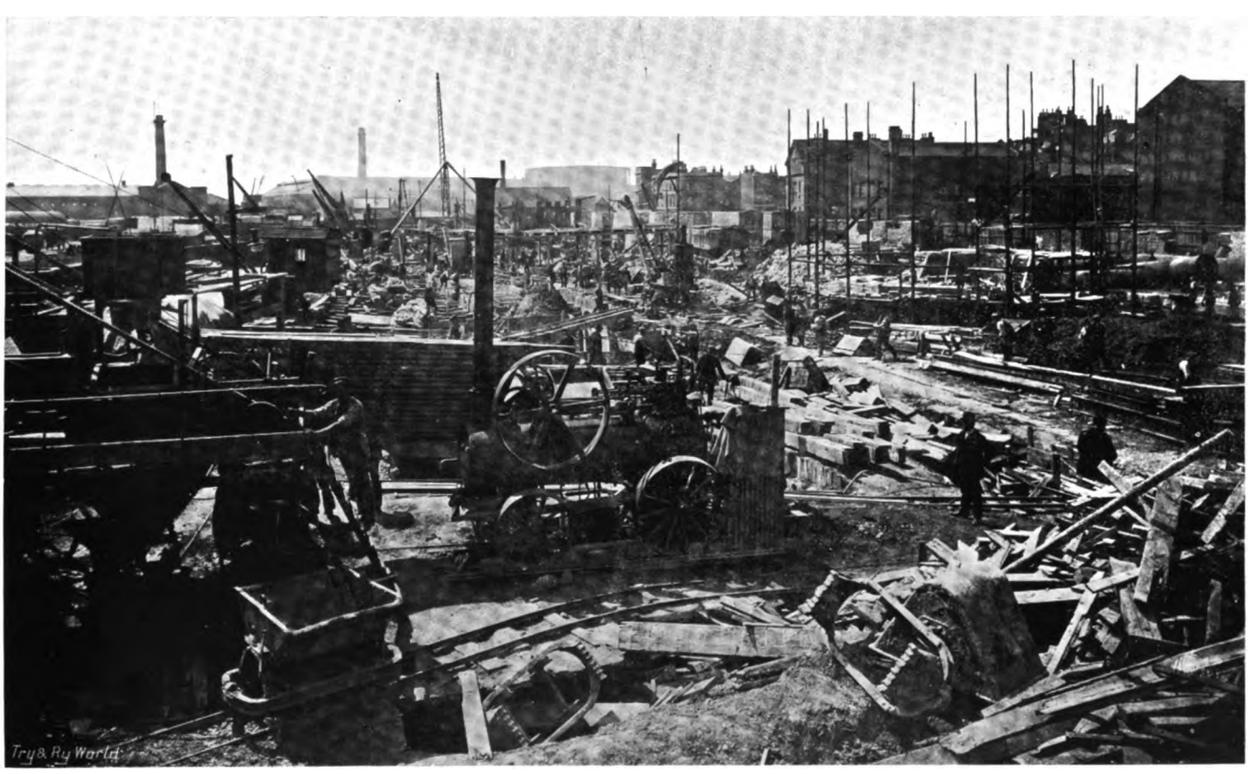

Fig 8.—General View During Foundation Work at Chelsea Station.

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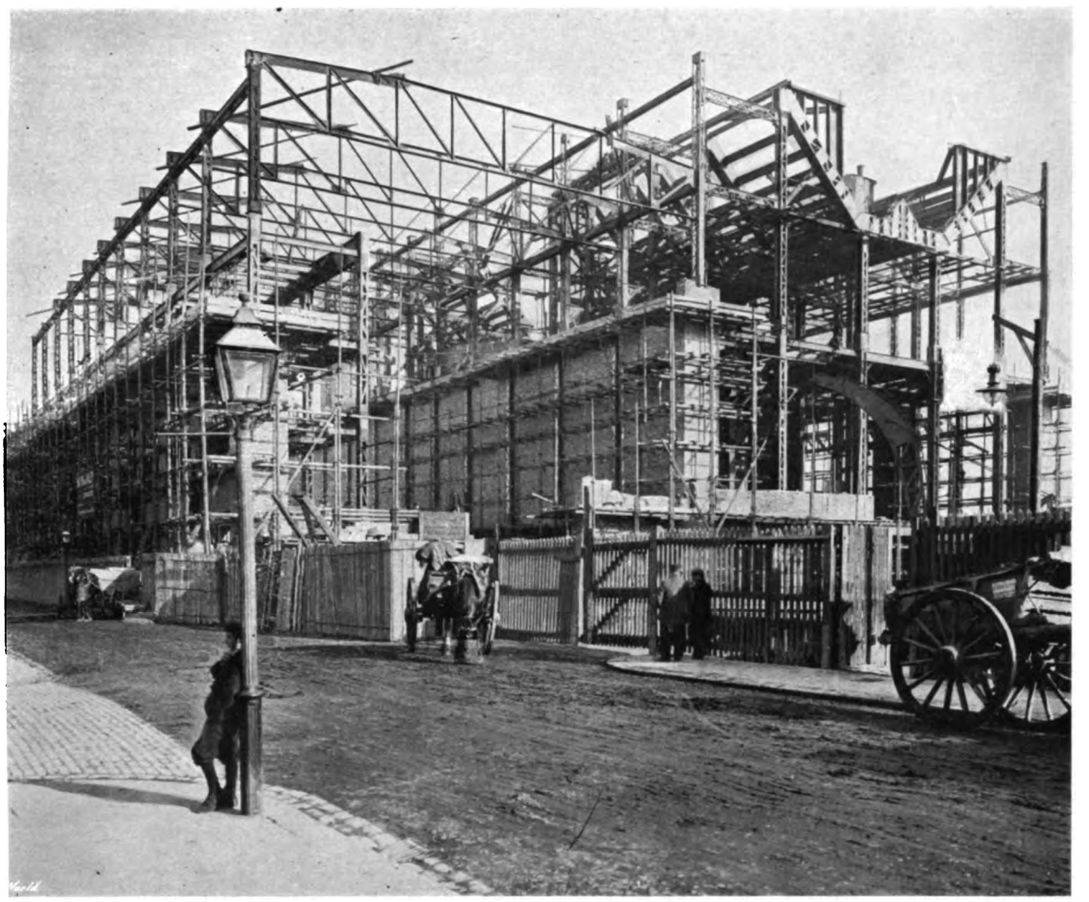

Fig. 9.—Chelsea Power Station in October, 1903.

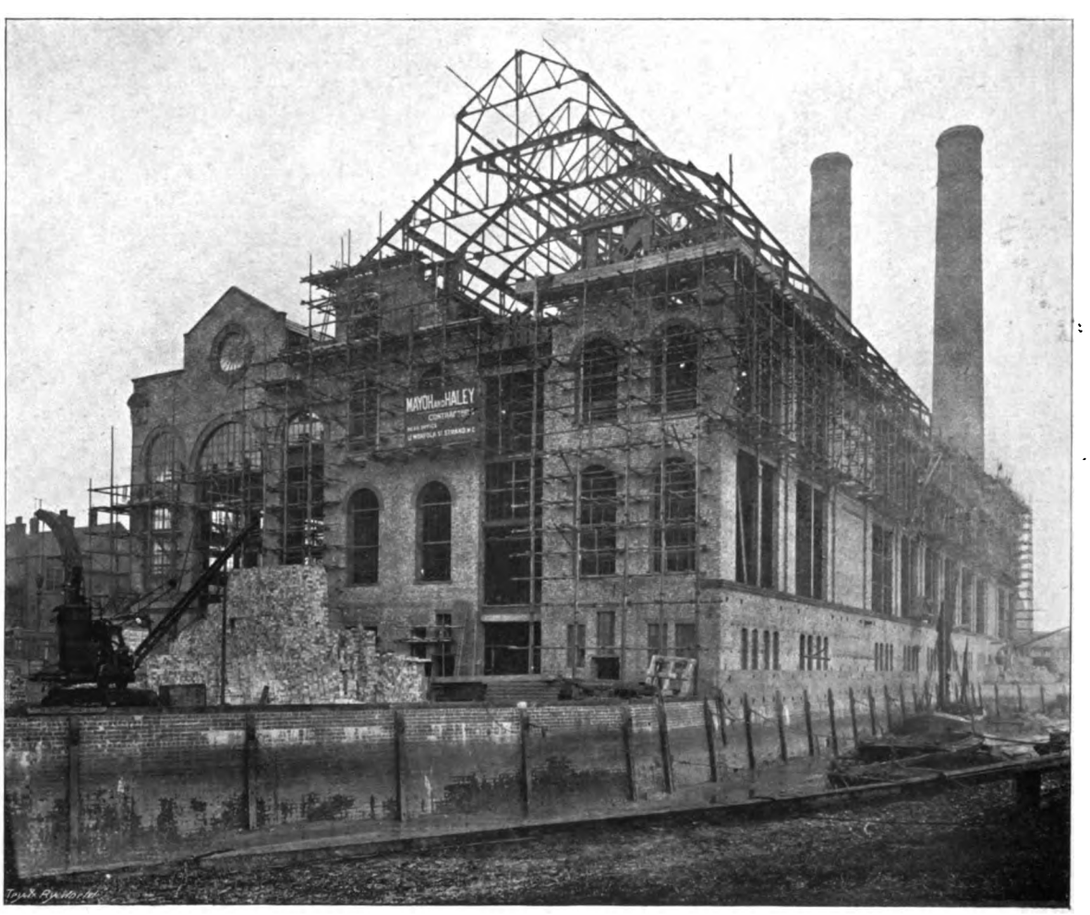

Fig. 10.—Chelsea Power Station in January, 1904.

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the water outside the dam blew away the ground under the bottom of the broken pile and filled the dam. To stop the blow, large quantities of puddled clay were tipped outside the broken pile, and in some cases sacks of cement were also used. When the blow was thoroughly stopped, the water was again pumped out of the dam, and the work was proceeded with. The pile engines, cranes, etc., were carried on a stage supported on piles, driven independently of the dam and about two feet outside of it, so that no vibration from the machinery should be communicated to the dam proper to cause leaks. The piles carrying this stage also acted as fenders to keep the barges used in removing the excavated material from bumping against the dam and damaging it. Over 10,000 cubic yards of earth were excavated for the wharf wall, and 6,000 cubic yards of concrete were used. Part of this wall, it will be noticed, forms the foundation for the greater length of the river-side wall of the boiler house. Some effective views of the site during the foundation work are given in Figs. 6, 7, and 8.

Barge Basin. — This basin, which accommodates the barges which arrive with coal for the station, is indicated at the right hand side of the general plan (Fig. 1). It is 220 ft. long by 80 ft. wide, and can accommodate six barges at a time. The construction of it formed part of the contract of Messrs. Perry and Company, as well as the construction of a valve chamber and the laying of most of the main circulating water pipes. The dam, which has already been described, was driven right across the entrance to the barge basin and enclosed it and the valve chamber, so as to keep the whole of the works water-tight. The entrance to the basin is formed of large blocks of granite, weighing about 5 tons each. The gates are built of greenheart timber, and are operated by pneumatic winches. By means of the gates the water is kept at full height in the basin at low tide. The walls of the basin are of concrete, faced with blue brick, and have a capping of creosoted timber. The floor of the basin is formed of 12 in. of concrete, having a layer of expanded metal bedded in it, and it is paved with blue bricks on edge.

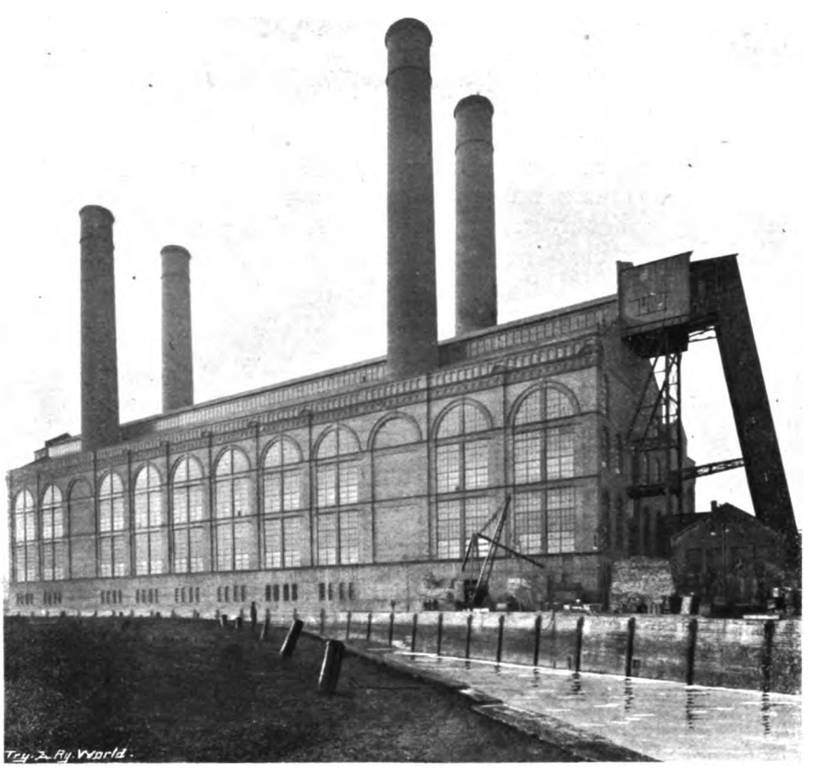

Fig. 11.—View of Power Station Building as Completed.

Main Circulating Pipes and Valve Chamber.— As the laying of the main circulating water pipes and the construction of the valve chamber formed part of the early work, their installation may be referred to here, though the details of the circulating water arrangements will be dealt with in the proper place when touching on the condensers. Two great iron pipes, the track of which is shown on the general plan by dotted lines, lead from the centre of the bed of the River Thames to the valve chamber, which is just inside the river wall and close to the barge basin, thence under that basin and the oil-cooling building to the engine-room, running along the whole length of that apartment in the basement. Outside the building, each pipe is 5 ft. 6 in. in diameter, while in the engine-room basement it steps down by degrees to 3 ft. 6 in. The total length of each pipe is about 1,500 ft.

The pipes from the centre of the river to the valve chamber are of cast iron, and were supplied and laid by Messrs. John Cochrane and Sons, Victoria Street, Westminster. A trench was excavated in the bed of the Thames, wide enough to accommodate the two rows of pipes, and of such a depth that when they were in place the top of them was on a level with the bed of the river. The lengths were then laid and bolted together. The whole of this work had to be carried out by divers. At the shoreward end a concrete foundation was put under the pipes, and a timber bulkhead was constructed across their mouths to keep the water from coming through into the workings for the valve chamber and the landward extensions. A manhole was provided in each pipe, through which a diver might get down to remove the bulkheads when

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the connection was made and the works completed.

The task of continuing the pipes landward from the river wall was entrusted to Messrs. Perry. These pipes are of riveted steel, so as to get a good hold of the concrete, and they were supplied by Babcock and Wilcox, Limited. As they are at a lower level than the bottom of the existing river wall, it was necessary to underpin the wall. It was in order to do this work and to construct the valve chamber that the dam had to be continued as above mentioned. The dam was led up to both sides of the pipe line, but it could not be completed in the ordinary way, as a space of about 15 ft. had to be left where the pipes were already laid. To close up this opening, horizontal sheeting composed of half timbers was bolted to the last piles on each side of the opening down to low water level. Below this point divers were employed to excavate the mud and fix the sheeting down to the pipes, round which it was cut and fitted with a water-tight joint. This was a long and tedious job, and when it was completed the divers were sent into the pipes to examine the bulkheads and caulk them where necessary. The trench excavated by the divers was then filled in with puddled clay to ensure a water-tight dam. This work being finished the water was pumped out of the dam, and the underpinning and the pipe work were completed. The piping under the barge basin and under the oil-cooling building was laid before these were constructed.

The valves in the valve chamber (the position of which is shown in Fig. 1) are used for controlling the circulating water supply. There is also a pipe connecting with the water in the barge basin, and it is controlled in the same chamber by a 48 in. valve. This arrangement is provided to allow of the basin gates being opened at the top of any tide. If, for example, the gates were closed at high tide, and it was found when it was necessary to open them again that the high tide was a foot or so lower than the level of the tide represented by the water in the basin, it would not be practicable to open the gates. By opening the valve in the connecting pipe the two water levels become the same, and the gates can then be opened.

In the course of Messrs. Perry's whole contract over 98,000 cubic yards of earth were removed, and nearly 40,000 cubic yards of concrete were placed. Twenty-one cranes were used on the work, and as many as 850 men were employed at one time. The work was carried on night and day, and 3,000 cubic yards of earth were excavated and removed and 2,000 cubic yards of concrete put in position each week.

THE MAIN BUILDING.

The power-station main building is 453 ft. 6 in. long, 175 ft wide, and 140 ft. high from the ground level to the peak of the roof. It is divided longitudinally by a partition wall into boiler-house and engine-room, each running the entire length of the building, and the former being 100 ft. wide and the latter 75 ft. The British Westinghouse Company obtained the contract for the steel frame of the building, and it was erected by Messrs. Mayoh and Haley (the Fulham Steel Works Company), as sub-contractors. Messrs. Mayoh and Haley also obtained a direct contract from the Underground Railways Company for the erection of the brick-work. In our issues of November 12, 1903, and August 11, 1904, we published a series of views showing the erection of the building at different stages, and some of these are reproduced here. (Figs. 9 and 10). Figs. 2 and 3 are a ground plan and section of the building.

In placing the order for this work, time was one of the essentials of the contract, and the rapidity of completion of the great structure is believed to form a record in this country. The steelwork was commenced in May, 1903, and was finished in December, 1904, while the brick-work was begun in June, 1903, and completed in March, 1904. The following particulars of the quantities of the materials used give some idea of the extent of the work:

Fletton bricks	6,000,000
Terra cotta in string courses, arches, cornices, etc.	17,000 cubic ft.
Specially made arch bricks, all of different pattern	85,000
Red pressed facing bricks	85,000
Portland cement	600 tons
Hydraulic lime	260 tons
Glass in windows	50,000 ft. super.
Paint	25 tons
Steelwork in framing and structure	6,000 tons
Sundry steel and ironwork not included in main structure..	2,000 tons

The whole of the steelwork framing was erected by means of Scotch derrick cranes, carried on bogeys travelling the whole length of the building. Of these there were employed during the construction two 7-ton and four 5-ton steam derricks, besides two 3-ton, two 2-ton, and several smaller hand derricks. These were fed with material by steam locomotive cranes, and were raised from floor to floor as the framing grew. The boiler-house roof was fixed by means of two 3-ton Scotch derrick cranes carried on a travelling gantry fixed on the top of the coal bunkers, 120 ft. from the ground.

The bricklayers and terra-cotta fixers were served by four double electric cage hoists fixed at various points of the building. There were also four steam winches for hoisting sundry materials, and the mortar mills in which all the mortar for the building was ground were driven by electric motors. The riveting of the steelwork in position was done by pneumatic hammers, and wherever work of any kind could be done better or more rapidly by machinery, the best modern power appliances were used in preference to hand labour.

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The work was exceptionally difficult, owing to the great heights at which parts of it had to be carried out, and the fact that provision had to be made for a number of separate contracts to be carried out at the same time without interfering with each other, in order that the whole building might be completed within the short period that it was. It was no small undertaking so to organise the supplies for such a huge contract that everything should be delivered by the time it was required.

The roof is of concrete, asphalte, and glass. The roof glazing was carried out by Mellowes and Company, Limited, Sheffield and London, on their well-known "Eclipse" system, which thoroughly excludes all moisture. On this method the steel sash bars are enclosed in a soft inoxydisible metal, and carry the longest squares of glass without any possibility of breakage, either by vibration or by expansion or contraction of the roof. No painting is required, and as the steel bars are entirely enclosed in the soft metal the glazing is practically indestructible. The confidence of Messrs. Mellowes on the last-mentioned point is shown by the fact that they have undertaken to maintain the glazing free of all cost to the Underground Railways Company for a period of ten years.

The basement floor is about 18 in. above the highest recorded tide in the river, and about 3 ft. below the level of Lots Road, and is 19 ft. high. Above the basement in the boiler-house are two floors, each carrying boilers, and the coal bunkers at the top. This basement is divided into three compartments for the entire length of the building. The middle division accommodates the boiler feed pumps, and the section on either side is devoted to the removal of ashes by a narrow gauge railway, the ashes being brought down by shoots. The boiler-room floors are built of concrete and expanded metal. There is a steel staircase at each chimney leading from the basement to the top of the coal bunkers. An electric lift is also provided between the basement and the second boiler floor. The coal bunkers can hold 15,000 tons, equal to nearly three weeks' supply, the full consumption being expected to be 800 tons per day.

As regards the engine-room, it will be seen that the turbo-generators are arranged in two rows, with the condensers, the latter in the basement, between them. Each engine foundation is 50 ft. long by 12 ft. wide, and 41 ft. deep. The floor is covered by checkered steel plates. The room is spanned by two 20-ton electric cranes by Messrs. Herbert Morris and Bastert. The crane motors, like those used for the oil switches, work by direct-current at 125 volts. All other motors used on the premises are worked by alternating current at 220 volts.

The switch gear and busbars extend the whole length of the building on three galleries along the wall next Lots Road. The gallery floors are of concrete and expanded metal. We may now proceed to details, beginning in natural order with the coal-conveying plant.

COAL-HANDLING PLANT.

The barge basin is spanned by two large gantry electric travelling cranes, which are shown in the view, Fig. 12. These were supplied by Messrs. Becham and Keetman, Duisburg, through Mr. A. Reichwald, their London agent. Grabs are worked from the top girders, and these grabs can each lift 1½ tons of coal at a time out of the holds of the barges. The grabs with their loads are travelled to the west side of the basin, where the coal is dropped into the automatic weighing apparatus, from which it descends through hoppers to a belt conveyor running below. The bases of the towers of these gantries are spread out to about 20 ft. square, and are carried on wheels which run on a broad gauge railway on each side of the dock. This railway has a slotted conduit after the style of the London County Council

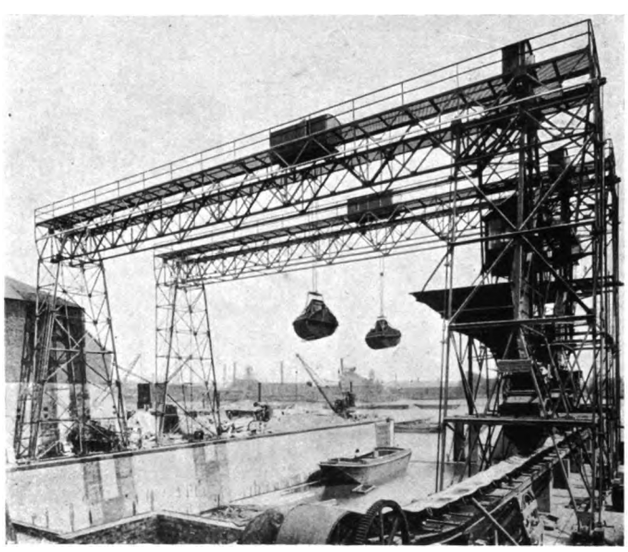

Fig. 12.—Gantry Cranes at Barge Basin.

electric tramways. Electric conductors are carried in the conduit, and contact is made with them by a current-collecting plough. The insulated leads from the plough are carried up the iron framework to the top of the gantry, where the motors for working the machine are situated. The lowering, raising, and travelling of the grabs are thus all controlled from above, and so likewise is the travelling of the whole gantry longitudinally on its two railways. The latter movement is effected by shafting from the top of the gantry, connected by bevel-wheel gearing at the top and bottom of the vertical tower. The final bevel gearing drives one of the wheels supporting each tower, and in this way the whole apparatus can be moved so that the grabs can be brought to bear on any barge at any part of the basin.

The coal-conveying gear served by the gantry cranes is of interest both on account of its magnitude and because it differs somewhat from

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that usually employed. An endless horizontal belt conveyor runs along the west side of the dock, the rollers on which it rests being supported on girders laid on concrete piers some four feet high, erected between the rails of the broad gauge gantry railway. The legs of the gantry tower straddle the conveyor, so that the coal is dropped from the hopper on to the belt. The length of travel of the conveyor is 190 ft., so that the total length of belt is fully 380 ft. The belt, which is made of an indiarubber composition, is 30 in. wide and ½ in. thick. It is carried in the usual way on horizontal rollers 5 ft. apart, while inclined rollers at the sides give it a slightly hollowed section so that it may hold the coal. At each end of the distance of travel are larger horizontal rollers which return the belt on itself underneath. The whole belt is driven by a 10 to 15 H.P. motor.

The belt conveys the coal to the base of twin-bucket conveyors, by means of which the coal is taken to the top of the building at a rate, if

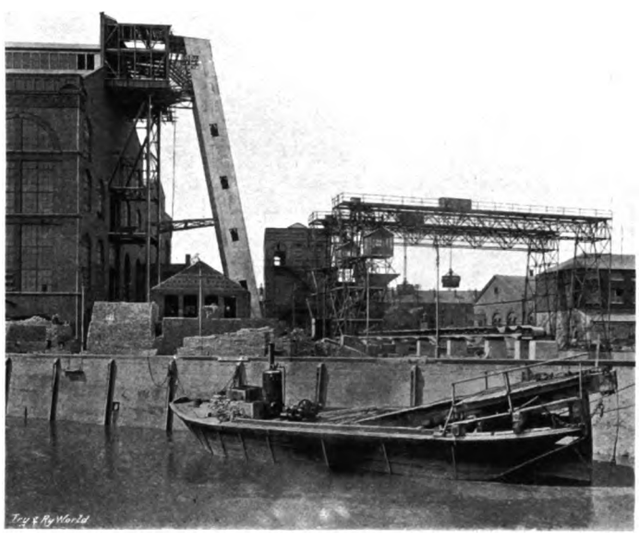

Fig. 13.—Coal Handling Plant.

necessary, of 240 tons an hour. The inclined conveyor is shown in Fig. 13. At its base is a small building, inside of which both the belt conveyor and the bucket conveyors are reversed. The belt passes over its large terminal pulley, and the coal drops through an inverted Y-shaped hopper into a coal crusher. From this it drops through another inverted Y-shaped hopper, the legs of which are spread at right angles to those of the first hopper. This second hopper is provided with a valve at the apex, so that the coal may be sent into either bucket conveyor or both. The lower end of the bucket conveyors is below, and the coal drops into the buckets just after they have turned their mouths vertically after going round the bottom pulley. The spouts of the hopper are made narrow, and the buckets are made with overlapping lips, thus forming a continuous shoot for the time being. The conveyor chain, connecting the buckets together, is formed by axles, links, and wheels. At the bottom, where the conveyor passes round its idler pulleys, provision is made for tightening the tension of the whole conveyor as required. The lift to the top of the boiler-house is 145 ft. 6 in. vertical, but as the conveyor is on a slope, the length of its travel, including short horizontal parts of the base and top, is about 200 ft. There are 154 steel buckets in each conveyor, spaced 2 ft. 8 in. apart, centres, so that the total length is about 410 ft., half of which at any one moment is ascending and the other half descending. These conveyors are driven by two 30 H.P. motors placed at the top

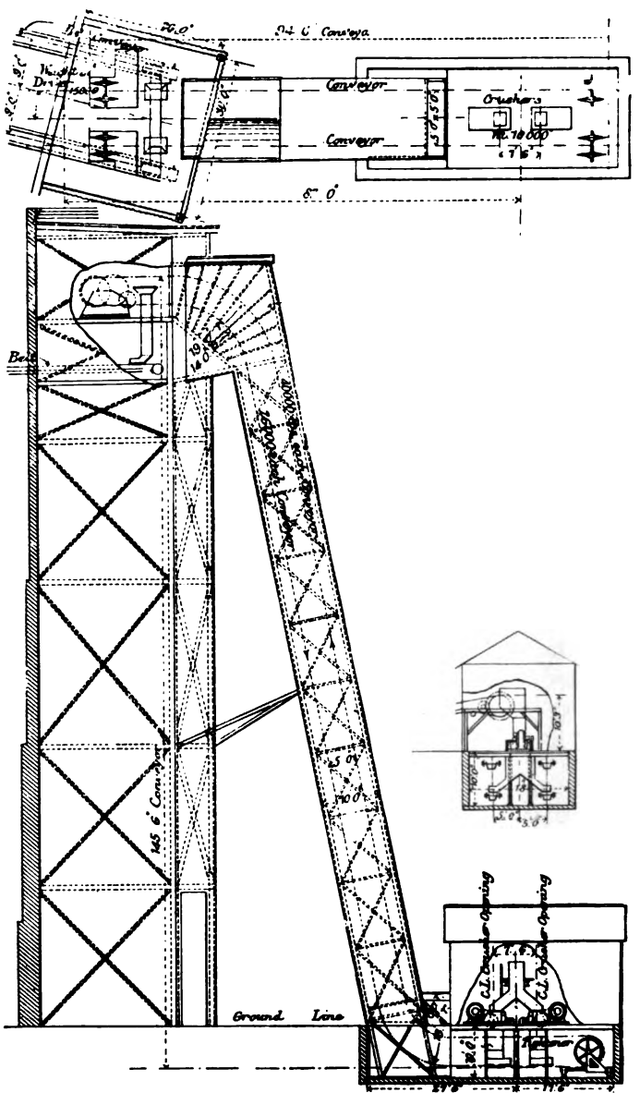

Fig. 14.—Elevation and Plan of Bucket Coal Conveyor.

of their travel. This is some 20 ft. above the level of two long belt conveyors which carry the coal along above the overhead coal bunkers and deposit it in them. The general arrangement is well shown in Fig. 14.

These horizontal belt conveyers are similar in arrangement to the one already described. The belt is, however, only 2 ft. wide and is $\frac{7}{16}$ in. thick. One belt is 980 ft. long and the other 970 ft.; these lengths are rather more than double the length of the building, but the belts are extended somewhat into overhanging

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projections at each end, particularly at the end where the bucket conveyors are. The pulleys carrying the belts are supported on longitudinal girders which in their turn rest on cross beams supported from the side walls of the boiler-house. The girders also carry a narrow gauge railway track for the coal-tipping traveller. Alongside each conveyor runs a gangway with a hand-rail, and this level is reached by stairs from below. Between the level of the conveyors and the bottoms of the coal bunkers the space is very great, so as to allow for the storage of the large quantity of coal required.

When the buckets of the lifting conveyors reach the top of their travel and turn round their terminal pulleys, the coal is tipped out of them into an X-shaped shoot. The upper mouths of this take the coal from the two chains of buckets, and the lower ends deliver it into pipes which lead it on to the belt conveyors. The shoot is fitted with a valve, so that the coal may be delivered into either or both of the belt conveyors.

Running on each narrow gauge railway track already mentioned is a small travelling carriage, the purpose of which is to tip the coal into the bunkers. This traveller is equipped with two pulleys of rather more than the breadth of the belt, one being higher than the other. The belt carrying the coal passes over the upper pulley, then slightly backwards and under the lower pulley, and thence continues its horizontal journey. Thus the coal is thrown off and falls into the bunkers. When it is desired to shift the traveller, so that coal may be dropped in another part of the bunker or in the next bunker, a clutch is closed, and the motion of the upper pulley is communicated by gearing to the wheels of the traveller. Thus the traveller can be moved about by the motion of the belt as desired, a reversing gear allowing the traveller to be moved in the opposite direction. Each belt conveyor is driven by a 20 H.P. motor. The bucket conveyors, known as the McCaslin overlapping type, were made by Messrs. John A. Mead and Company, New York, while the belt conveyors were manufactured by Messrs. Mead, Morrison and Company, also of New York. The enclosed steel tower for the bucket conveyors was erected by Messrs. Mayoh and Haley.

Arrangements have also been made for taking coal in at the western end of the building from the sidings of the West London Extension Railway on the other side of Chelsea Creek. The coal is to be dumped from the railway wagons into hoppers which will deliver it to an inclined bucket conveyor. This conveyor will span the creek and lead up to the top of the boiler-house, where the coal will be delivered on to the horizontal belt conveyors. The motion of the latter can be reversed when the coal is coming in from the west end. The Underground Railways Company have made all the arrangements for erecting this conveyor, but the railway companies owning the sidings have been dilatory in settling their part of the matter, so that the conveyor has not yet been built.

STEAM-RAISING PLANT AND AUXILIARIES.

Boilers.—The arrangement of the boilers is unique in this country, as they are carried on two floors, thus saving much ground space. On each floor there is a double row of boilers, with a wide firing floor between them. The boilers are supported by the building stanchions, and are entirely independent of the brickwork. A capital view of the boilers on one floor is given in Fig. 15.

When the extensions of the power-station are completed there will be a total of 80 Babcock and Wilcox patent water-tube boilers, of that company's standard land type, each having 5,212 square feet of heating surface. At the present time 64 of these boilers are in position. They are arranged in groups of eight, four of these groups being on the first floor and four on the top floor. The relative lightness of the boilers enables this to be done, while the power of each boiler, capable as it is of evaporating 17,000 to 18,000 lbs. of water per hour, would be impossible in the circumstances with any but a water-tube boiler. The size here used, however, by no means represents the limit, as the company have manufactured boilers of this land type having considerably over 6,000 square feet of heating surface, and capable of evaporating upwards of 20,000 lbs. of water per hour; while of their marine type, which has a much higher duty per square foot of heating surface, owing to its larger relative grate area, the highest evaporation, as represented by the boilers installed by this company at the Carville power-station, Newcastle, reaches to upwards of 25,000 lbs. of water per hour.

Each boiler is constructed of 20 sections of 4 in. straight seamless steel tubes, 18 ft. long, expanded at each end into wrought steel headers (uptakes and downtakes), which are connected by 4½ in. diameter nipples to two steel steam and water drums 54 in. in diameter and 23 ft. 7 in. long, these being joined at the rear end with a 6 in. wrought steel cross-pipe, on which the steam stop valve and safety valve are placed, the working pressure being 175 lbs. per square inch. Each boiler is provided with a wrought steel mud-drum. The whole boiler, constructed according to best English practice as far as workmanship is concerned, and in accordance with modern ideas, is of steel.

Mechanical Stokers.—The mechanical stokers attached to each boiler are of the Babcock and Wilcox patent chain grate type, each having an area of 83 square feet. The grate consists of an endless chain of short cast iron grate bars, linked together and actuated by passing over drums at the front and rear, the front drum being revolved by a worm and worm wheel.

The whole stoker can be brought out clear of the boiler, the frames being provided with

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wheels running on rails placed at the sides of the ash pit, although this is not necessary for merely replacing a defective bar, which can be done in a few minutes with the stoker in place.

The coal is fed over the whole width of the grate, and the depth of the fire regulated by the adjustment of the vertically lifting fire doors. The feed of the coal which descends by shoots from the bunkers above, is slow, and the gas evolved from the fresh fuel as it drops on to the grate readily perfects its combustion by passing over the incandescent fuel further on.

The speed of the travel of the grate is regulated by a ratchet and pawl adjustment on the driving worm, which latter gears into a worm wheel, on the shaft of which are the drums which revolve the grate. The stoker can be adjusted in a moment to suit the class of fuel to be consumed and varying demands for steam can be met both by the depth of the fire and speed of the grate. The fire does not require to be touched with the firing tools, the stoker being self-clinkering. Undue admission of air at the back end is prevented. Hand firing may be resorted to at a moment's notice without removing the coal from the hopper. The fire doors are large, extending the whole width of the grate. By means of this stoker inferior coal can be burnt, while, which is most important for London, these chain grate stokers ensure the absence of smoke.

Superheaters.—The boilers are fitted with Babcock and Wilcox superheaters. Each superheater is arranged in the triangular space between the drum and the water tubes. The superheat given is 150 deg. Fahr., making the total temperature of the superheated steam delivered 530 deg. Fahr. The saturated steam is taken through a dry pipe from the steam space in each drum by means of two 4 in. steel pipes, each of which is expanded at the lower end into a nozzle riveted on the under side of the drums, and is carried through and again expanded into the upper box or manifold of the superheater. The space in this upper manifold is divided off by means of a number of wrought diaphragms, the object of which will presently be noted.

The steam entering the dry-pipes fixed on the top of the inlet pipes passes through the latter into those divisions of the upper box which are immediately underneath the steam and water drum; thence through U-shaped tubes, of mild steel, solid drawn, into the lower box or manifold of the superheater, into which the tubes are expanded. Dividing to right and left, it enters the central as well as the two outside divisions of the superheater. It finally passes through the three outlet pipes expanded into the upper manifold, thence into the cross-piece above the steam and water drums, from whence it is taken through the stop valve to the steam main; thus the steam passes twice through the heated gases, thereby increasing its temperature to the desired amount of superheat. Each superheater is fitted with an arrangement of piping and cocks, enabling the attendant to fill the tubes and boxes with water before starting the boiler.

There is also a saturated steam connection on the top of the drums for the purpose of providing for mixing a small quantity of saturated steam with the superheated steam if desired. All parts of the superheater which are exposed to the action of the furnace gases are of mild steel, and of very high tensile strength.

Steam Piping.—The arrangement of the steam piping, which was manufactured and erected by Babcock and Wilcox, Limited, in connection with the 64 double drum boilers, is as follows: Steam is taken from each boiler stop-valve by means of 6 in. solid drawn, weldless steel pipes to one large header, there being eight of these headers, one to each group of boilers. The pipes are so arranged that the expansion is taken up in easy bends; it is thus possible to shut down any one or more of the boilers without interfering with the efficiency of any of the other boilers in the group. From these headers steam is conveyed to the eight turbine generator units, by means of 14 in. lap-welded steel pipes. The arrangement is such that each unit has its own group of eight boilers providing steam.

There is also a 10 in. auxiliary header for supplying steam to the exciting engines. The steam is conveyed to this header from three of the large headers by means of 10 in. solid-drawn weldless steel steam pipes. In the large pipes, as in the case of the small, the expansion will be taken up by easy bends, no special expansion bends being necessary. The whole of the flanges are of stamped steel. In the case of the 6 in. pipes, they are screwed on and afterwards expanded. In the case of the 10 in. and 14 in., they are riveted. No cast iron whatever has been used in connection with the pressure piping.

Economisers.—Green's economisers are used throughout. This, we believe, is the largest single economiser installation in the world, and comprises a total number of 9,216 tubes. In the installation there are twelve economisers of 576 tubes each, 8's in width, in four groups, to permit of easy access to all parts of the apparatus. The economisers are specially constructed for high pressure, and the tubes are 10 ft. long and 10¼ in. and 12½ in. centres, instead of the ordinary standard size of 9 ft. long and 8 in. centres. This is to give more area for the gases. There are also eight economisers of 288 tubes each, 10¼ in. centres, 8's in width, and each apparatus is arranged in two groups; therefore one economiser of 288 tubes (3,281 square feet heating surface) deals with the waste gases of each four boilers. The economisers are erected directly behind the boilers and over the main flue. The dampers are so arranged that any particular boiler unit and its economiser can be stopped off when desired. The gearing for working the scrapers is driven by 16 electric motors fitted with worm reduction gear, being coupled direct to the economiser shaft. One

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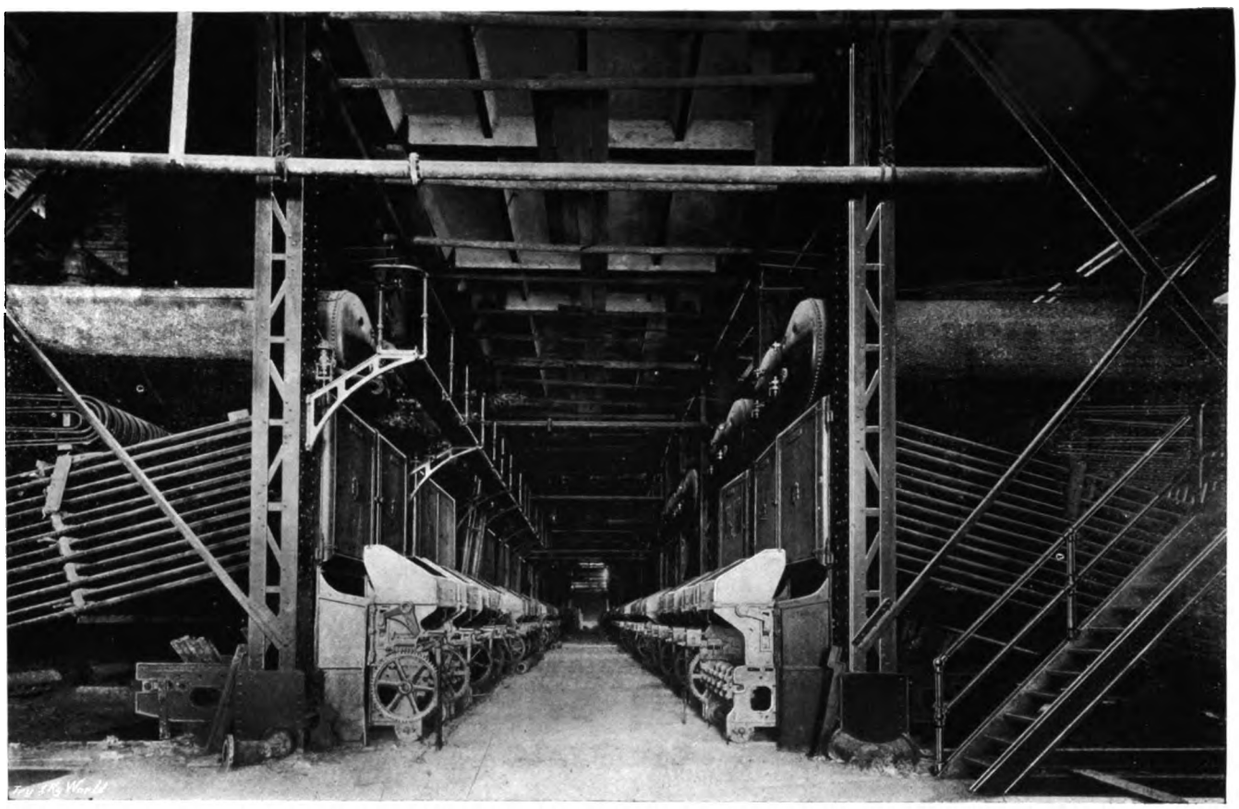

Fig. 15.—One Floor in the Boiler House.

Fig. 16.—Interior of Engine Room in July, 1904.

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motor is allotted to each 576 tubes. Each economiser is fitted with two themometers for registering the temperature of the feed water entering and leaving the apparatus, and a tell-tale pressure gauge, whilst on each group of tubes safety and blow-off valves are fitted. The economisers throughout are fitted with patent access branch pipes at the bottom to facilitate cleaning out operations. The total heating surface of this great economiser plant is 105,000 square feet.

Chimneys.—The gases, after passing through the economisers, are led to the four great chimneys of the buildings. These are seen in several of the views presented herewith. Each chimney is 19 ft. internal diameter at the base, and 275 ft. high from the basement floor. The foundations of each chimney are 42 ft. square and go down to a depth of 34 ft. 6 in. below the same floor into the London clay. The concrete in each foundation amounts to 2,000 cubic yards. The chimneys are of the Alphons Custodis type, and were built by the Alphons Custodis Chimney Construction Company.

Ash Removal.—The ashes from the funaces drop through shoots to the basement, where they fall into self-dumping buckets which run on a narrow gauge railway. There are two lines of this railway running the whole length of the building, and the haulage is done by a storage battery locomotive, supplied by the British Thomson-Houston Company. The ashes are thus run out to the west end of the premises, where they are unloaded into barges by pneumatic hoists on the river wall, or stored in an ash pocket if no barge is available at the time.

Feed Pumps.—In the basement of the boiler-house are eight boiler feed pumps, seven made by the Worthington Steam Pump Company, and the eighth a Heisler pump from Erie, Pennsylvania. The latter is a triple expansion pump with a compensating valve gear, and it is stated to be very efficient. The Worthington pumps are of the vertical simplex-compound type with centre packed plungers. Each has a 16½ in. high-pressure and a 26 in. low-pressure steam cylinder, and two 9½ in. pump plungers, and the stroke is 18 in. Each set of pumps is capable of delivering 300 gallons of water per minute, or 18,000 gallons per hour, against a boiler pressure of 225 lb. per sq. in., with a steam pressure of 165 lb. These pumps are of a special design, and are similar to four sets which the Worthington Company built for the Stuart Street generating station, Manchester. The steam ends have a special form of piston valve motion, and steam is used expansively, taking high-pressure steam in the smaller cylinder and exhausting into the larger. The pump ends have polished plungers to reduce

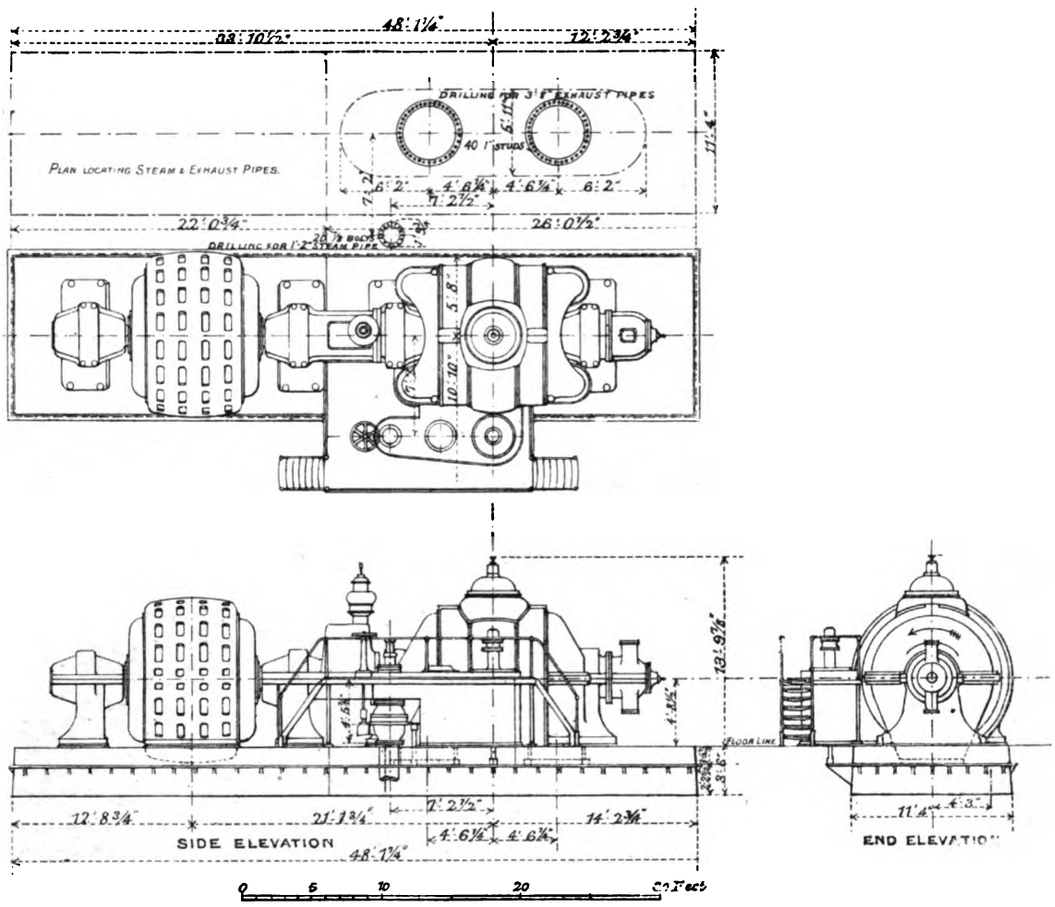

Fig. 17.—Plan and Elevations of 5,500 kw. Turbo-Generator.

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frictional conditions to a minimum. The pumps are so arranged that either side can work as a single pump, or running together they can work as one compound set. They are complete in every way, having special oil pump, steam

Fig. 18.—Rotor of 7,500 h.p. Steam Turbine.

receiver, and connections between either side. The valve motion is positive, and a very high duty is obtained from the pumps, which deliver at the rate of 120 lb. of water per 1 lb. of dry steam. Each set of pumps is about 14 ft. high by 8 ft. wide.

Feed water is taken from a large storage tank which is placed on the second floor of the oil-cooling house outside the east end of the main building. The water for supplying this tank is obtained from an 8½ in. Artesian well, 575 ft. deep. As a precaution against any insufficient supply from the well, there is a connection with the public water mains, and a float valve keeps the water at a constant level. In the extremely improbable event of both these sources of supply failing, river water may be turned into a suction pipe which has connections with each pump. Each ring main header is supplied by two pumps, and either of these pumps can feed either of two groups of boilers, or, when the load is light, both groups. The exhaust steam from the pumps passes into a heater, where it is used to warm the feed water. The heaters are connected to a common header open to the atmosphere. The exhaust steam when condensed may flow by gravity either into drainage manholes or into a sump used for the drainage of all steam traps.

THE TURBO-GENERATING PLANT.

When completed the power-station will have ten sets of turbo-generators, and an auxiliary half-size set, having a total capacity of nearly 80,000 brake horse-power, and there is a considerable margin for overload. At present eight of the sets are being installed, all of which are supplied and erected by the British Westinghouse Electric and Manufacturing Company. The sets are the largest of their kind which have yet been manufactured, but in principle they are similar to those now running in the Metropolitan Railway power-station at Neasden. Each set consists of a 5,500 KW. steam turbine of the Westinghouse Company's latest design, direct-coupled to a three-phase alternator. The brake horse-power is over 7,000. These units run at a speed of 1,000 revolutions per minute, aud deliver current at a pressure of 11,000 volts and a frequency of 33⅓ cycles per second to the various sub-stations.

Turbines.—The turbines are of the single-cylinder double-flow type. The steam pressure is 165 lb. per sq. in., and the superheat at the turbine 100 degs. Fahr. The permissible overload is 50 per cent., and it is dealt with by an automatic by-pass. The general design and construction, as well as the leading over-all dimensions, may be gathered from Figs. 17 to 22, which show units being erected in the power-station, some which are completed, various parts, and a dimensioned drawing.

The steam enters at the centre of the cylinder and passes through a series of nozzles and impulse blades, this operation being repeated until the steam has expanded to about atmospheric pressure. After this it passes through a series of pressure blades on the Parsons principle until the exhaust is reached. As the steam enters at the centre and flows both ways, the shaft is kept in perfect equilibrium; thus all end thrusts are eliminated, and the necessity for balance pistons, etc., to take these up is done away with. A

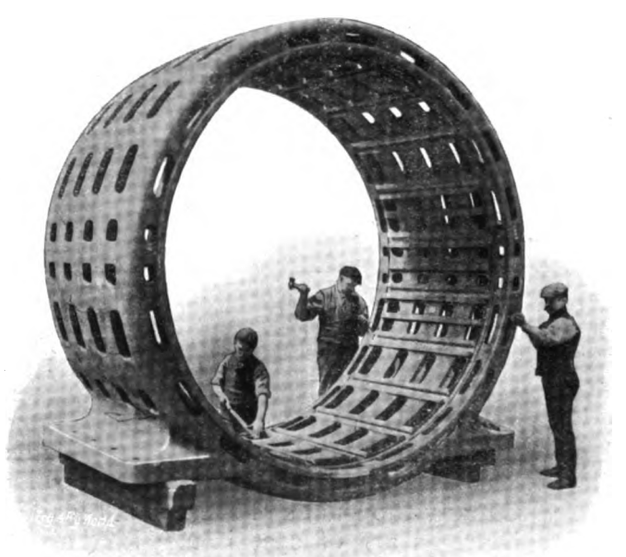

Fig. 19.—Armature Frame of Generator under Construction.

thrust block, however, is fitted at the extreme end of the cylinder, but this is only for the longitudinal adjustment of the moving part.

The rotating portion consists of a rolled steel drum 6 ft. 5 in. in diameter, a forged steel umbrella-shaped disc being shrunk into each end. The high-carbon steel spindle ends are pressed

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into these discs at the same time, with the result that the whole makes an extremely light though strong construction. As each part can be machined all over, the balancing difficulties met with in cast steel and other unhomogeneous materials are virtually eliminated. The first series of blades are let into the dove-tailed grooves of the cylinder and spindle. The low-pressure blades which are of larger size are of special metal, the material preventing any corrosion due to wetness of the expanded steam. The numerous rings of blades may be seen in Fig. 18.

From other illustrations it will be seen that the casing of the rotor is in two halves, securely held together by numerous large bolts through heavy flanges. Internally the casing is provided with rings of fixed blades, these rings almost filling the spaces between the rings of blades on the rotor. All blades being set at the proper angles, the steam is thrown alternately from fixed to moving and from moving to fixed blades till it reaches the exhaust. In each turbine there are many thousands of these small blades.

The bearings are of cast iron, with babbitt metal linings, and have spherical seats. Keys, liners, etc., are provided to admit of the finest adjustment. The forged steel coupling connecting the turbine and generator is of the flexible claw type and runs in oil. It transmits the full power of the shaft, and at the same time has sufficient latitude to allow the generator and turbine shaft to revolve about independent centres, so that any want of exact alignment is immaterial.

The arrangement of valves is as follows: the steam enters through a main disc-type stop valve, which is connected through gear wheels with a hand wheel on the platform. It then passes through an emergency shut-down valve, steam strainer, and governor valve of the double-seat poppet type into the cylinder. A centrifugal governor directly driven through gearing from the turbine shaft operates the poppet valve through a small steam relay, so that this admission valve is directly controlled by the speed of the turbine. At the end of the turbine shaft opposite to that at which the centrifugal governor is attached is fitted an emergency governor. The latter is set so that should anything happen to the centrifugal governor, and the speed of the turbine reach a predetermined maximum, the emergency governor will come into operation, and open a small valve, which in its turn will close the emergency throttle valve above referred to.

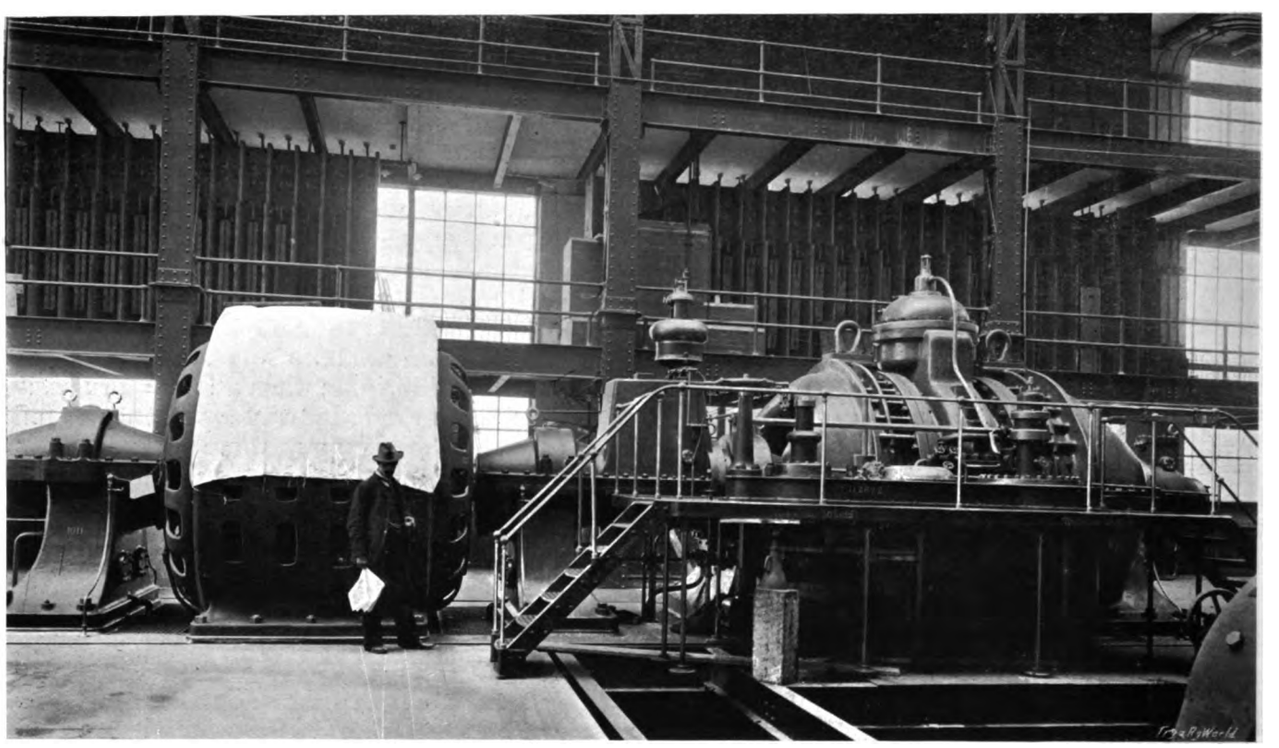

Fig. 20.—Completed Turbo-Generator, 7,500 Horse-Power.

A centrifugal lubrication system is provided, oil being supplied under pressure to each machine, an oil pipe leading up from the oil main to the centre of each bearing. The combination bedplate of each turbo-generator weighs about 52 tons.

Generators.—The 3-phase alternators are of the revolving field type, and have a normal output of 5,500 KW., viz., 289 amperes per terminal at 11,000 volts with a non-inductive load. As already mentioned, the frequency is 33⅓ per second, and the speed 1,000 r.p.m. The fixed armature shell consists of a laminated ring with slots on its inner surface, and the ring is supported

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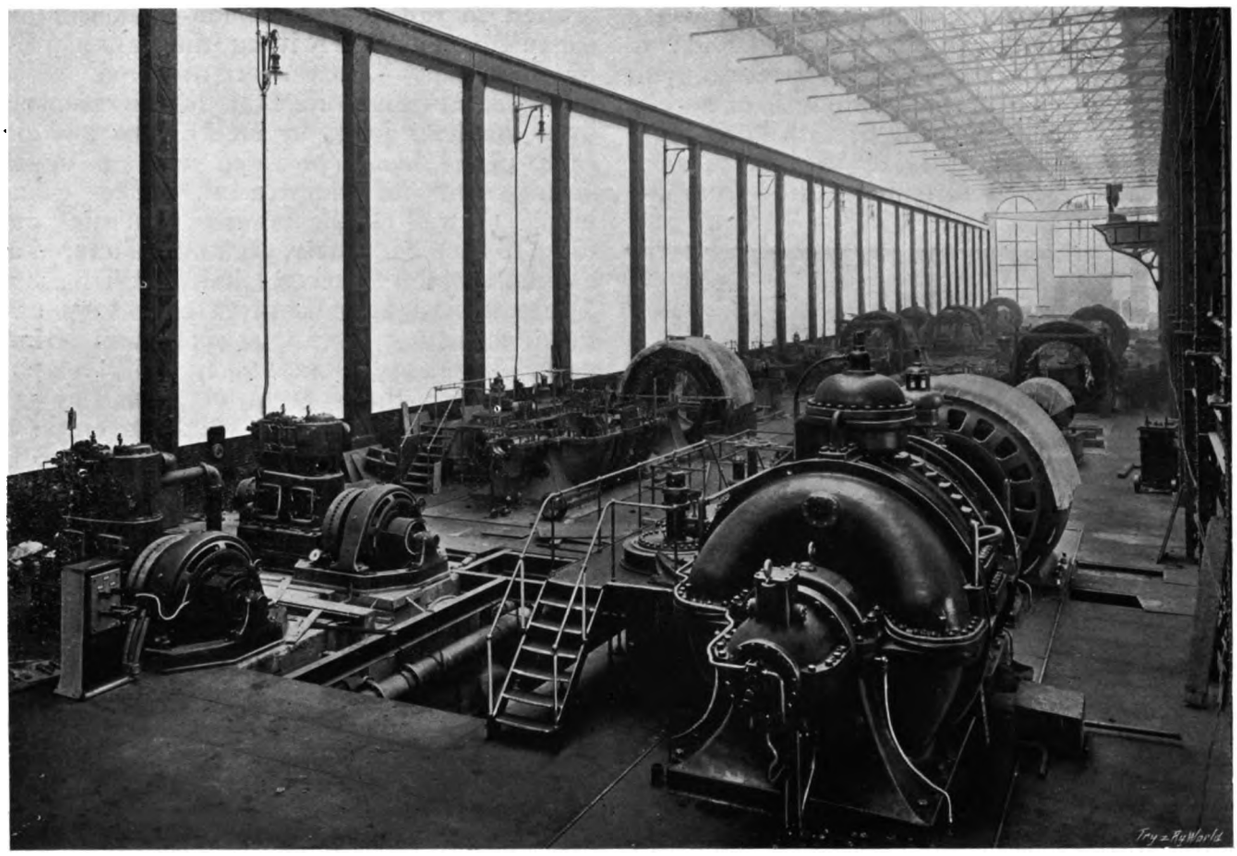

Fig. 21.—View in Engine Room.

Fig. 22.—Turbo-Generators under Erection, November, 1904.

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in a massive cast-iron frame (Fig. 19) which is divided horizontally. The revolving field core is made of a solid forging which is pressed upon a high carbon shaft. This forging is of special steel which combines strength with good magnetic permeability. It is of Whitworth fluid pressed steel, which is manufactured from the

Fig. 23.—Winding Generator Fields.

best Swedish iron. The latter is melted in a Siemens-Martin furnace and afterwards run into extra strong, specially prepared steel mould boxes, and then subjected to hydraulic pressure whilst in a fluid state. By this means a much greater soundness is obtained than is possible when the metal is cast in the ordinary way. The material is afterwards taken and reheated and forged under a powerful hydraulic press (10,000 to 12,000 tons), this ensuring the metal being thoroughly and uniformly worked. Lastly, the pieces are rough machined and carefully annealed before the finished machine work is done. Each rotor has four field poles, the method of winding which is shown in Fig. 23. The work of winding the armature coils is indicated in Fig. 22.

Condensing Plant.—As the turbines are of the double-flow type, the steam entering midway and exhausting at each end, every turbine is fitted with two exhaust nozzle pipes, which are carried direct from below the ends of the turbine to a great condenser in the basement. These condensers, as may be seen from the ground plan of the engine-room, are situated in a central line between the two rows of turbine foundations. Each of the exhaust pipes is of cast iron, coated outside with asphalte paint, and is 44 in. in diameter. The exhaust pipes connect by means of large automatic valves (made by Mr. G. M. Marchent, Huddersfield), with a main range of exhaust pipes, 311 ft. long and of 5 ft. bore, made of riveted mild steel with heavy cast iron tees and bends. In this range there are three vertical 5 ft. bore uptake riveted mild steel pipes, which are taken up the sides of the chimneys to a height of 106 ft. from the ground level. When for any reason it is desired to run the plant non-condensing, the exhaust steam, by shifting the valves, passes by these pipes into the atmosphere. All this pipework in the horizontal run is suspended from the floor joists by steel chains and clips, each chain being provided with a suitable arrangement for adjustment. The exhaust piping, as well as the branch circulating water pipes to each condenser, were manufactured and erected by John Spencer, Limited, Wednesbury. The total weight of cast-iron pipes supplied by them, consisting of various sizes from 60 in. to 20 in. diameter, is 420 tons, while the steel piping which they put in, of 60 in. and 54 in. bore, totals 51 tons. The weight of one of the large 60 in. diameter cast-iron bends is no less than 7 tons.

The condensers, which have been specially designed by the Underground Electric Railways Company's engineers, and made by Messrs. J. M. Simpson and Company, are of a vertical surface-condensing type. The external appearance may be gathered from Fig. 24. There is one condenser for each turbine, and it has 15,000 sq. ft. of cooling surface. This is provided by 3,822 tubes, each 15 ft. long by 1 in. in

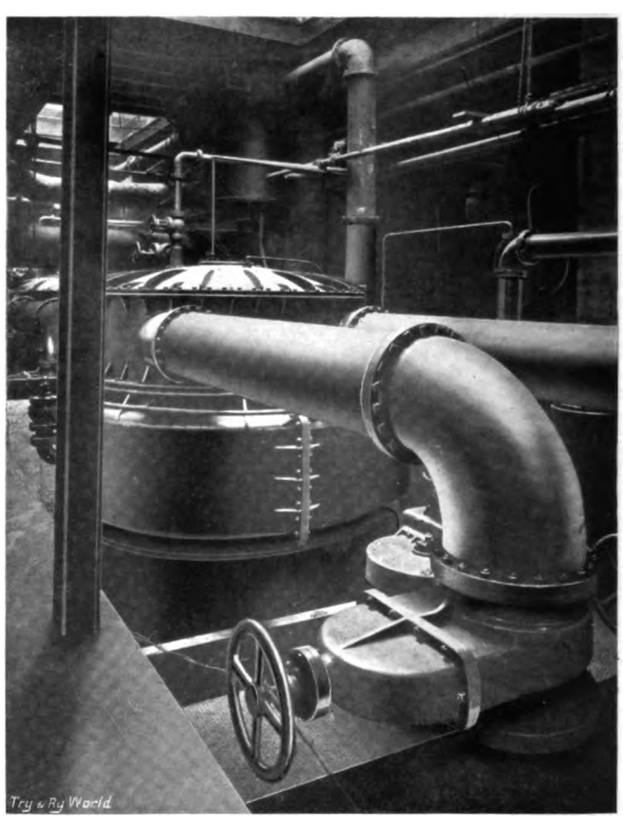

Fig. 24.—Condenser and Piping.

diameter. The tubes, contrary to the usual practice, are vertical, and the steam space is exceptionally large.

The circulating water, as previously described, is obtained from the Thames through two steel pipes, each 5 ft. 6 in. in diameter. The pipes run the whole length of the engine-room

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basement, and cast-iron branches, 20 in. and 22 in. in diameter, lead off from them to each condenser. The mains step down by 6 in. diameter at a time till at the west end of the basement they are only 3 ft. 6 in. in diameter. Their ends are there turned up and closed. This piping is so arranged that the flow of the circulating water can be reversed when desired, either pipe serving in turn as intake or outlet. Any mud or sediment entering is in this way washed out again into the river.

Each condenser is provided with a 20 in. Worthington centrifugal pump, driven by a three-phase motor. The tops of the condensers are not more than 29 ft. above minimum low tide in the river, and this arrangement has been adopted in order that the circulating water may flow on the syphon principle. The whole duty of the pumps therefore is only to overcome the friction of the water in the pipes. There are also provided for each condenser a Worthington electrically-driven dry vacuum pump, 24 in. by 18 in., and a 4 in. electrically-driven centrifugal pump by the same makers, the latter being used for delivering the water of condensation to the hot well. From this the boiler feed-pumps take it back to the boilers, no oil-extraction being necessary, as no lubricating oil enters the interior of the turbines. The only additional feed water necessary is that required for the auxiliary machinery and for compensating station losses. The vacuum maintained by the condenser pumps is equal to about 27 in. of mercury.

Exciter Engines.—This plant is of some interest, as it is of unusual power. It consists of four sets of engines and dynamos, aggregating an output of about 600 KW. These machines are situated, as shown on the plan, at the east end of the engine room at the side nearest the boiler house. The engines have been supplied by W. H. Allen, Son, and Company, Limited, Bedford. They are of the firm's standard two-cylinder compound enclosed type, and are fitted with the usual forced lubrication system. The cylinders are respectively 12 in. and 21 in. in diameter, with a stroke of 9 in., the normal speed of the engine being 375 revolutions per minute. Each set is direct-coupled to a continuous-current British Thomson-Houston dynamo; a complete base-plate extends under the full length of engine and dynamo, the whole forming a rigid design

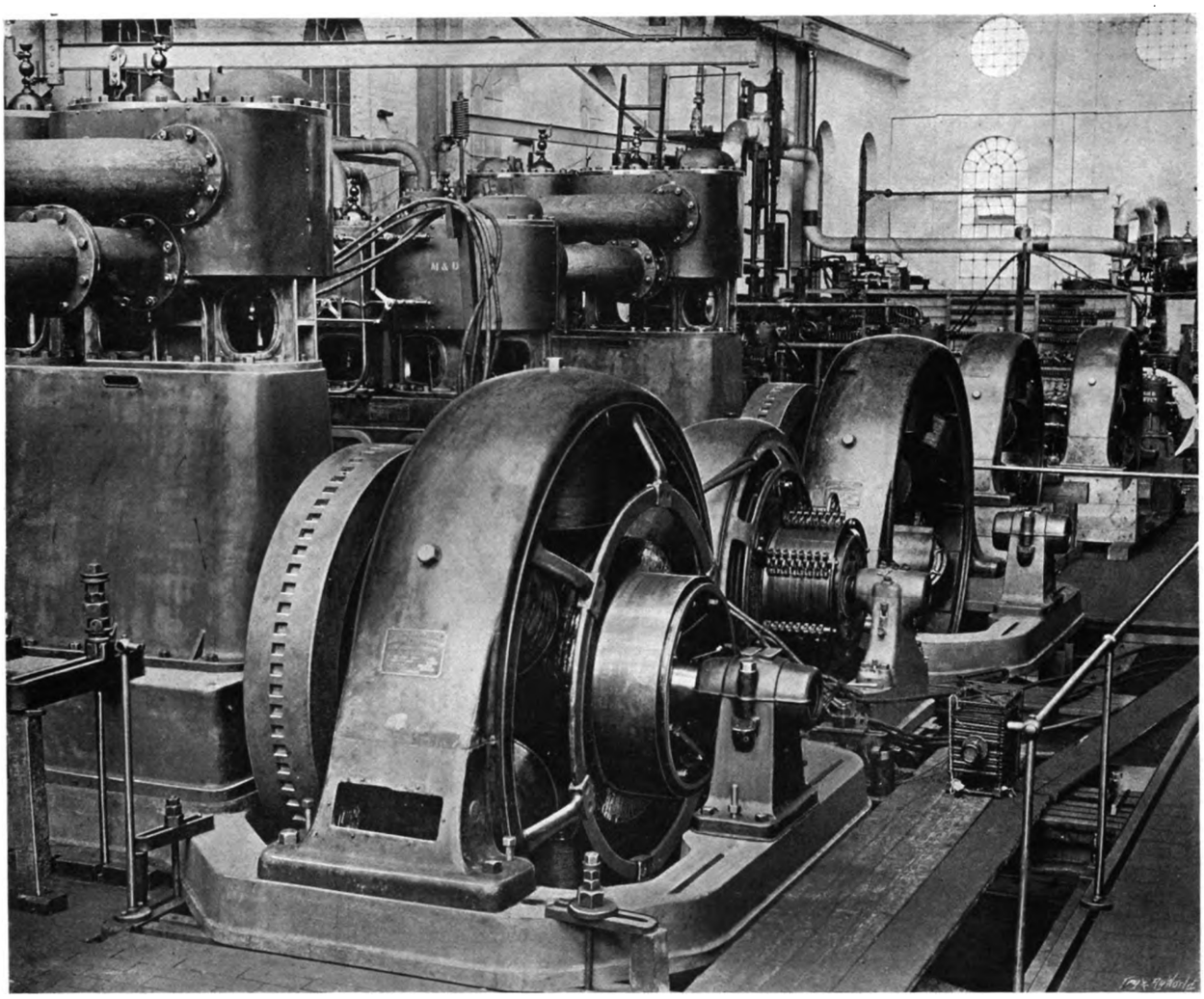

Fig. 25.—View of Exciter Sets when under Test.

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of neat appearance. Fig. 25 is a view of the sets when under test. Each engine develops 200 H.P. at full load, with steam pressure of 165 lb. per sq. in. at the stop valve, a superheat of 23 deg. Fahr., and a vacuum equal to 24 in. of mercury. The water consumed per indicated horse-power is 15·7 lb., or 25·4 lb. per KW. hour. The engine is designed to run at 25 per cent. overload for considerable periods.

The exciters are of the British Thomson-Houston Company's well-known standard continuous-current type. They are 6-pole machines, each of 125 KW. capacity, and at 375 revolutions per minute generate current at a pressure of 125 volts. They are flat compound-wound, and rated to take 25 per cent. overload for two hours without moving the brushes or sparking, and they will carry 50 per cent. overload momentarily.

Oil-Cooling Plant.—This is a department which does not exist in most generating stations, as, especially with slow-speed reciprocating engines, there is not much necessity for it. With turbines, however, running at 1,000 revolutions per minute, the case is different, and the oil attains a considerable temperature in passing through the bearings. Each turbine and dynamo require 33 gallons of oil per minute to be circulated through their four bearings, making 264 gallons per minute if the eight turbines were running simultaneously. The result is that besides floating the shaft in the journals on oil, the rapidly circulating oil carries away the heat evolved. A complete oil circulating system, analogous to the circulation of steam condensing arrangements, has been provided. Outside the main building, at the east end, as shown on the general plan, an oil-cooling building, some 50 ft. high, has been erected. The basement and ground floor are occupied by three large oil-coolers, made by Messrs. J. M. Simpson and Company, and by oil tanks, while the third floor accommodates oil-filtering and gravity tanks. The second floor, as previously mentioned, is devoted to a feed-water storage tank. The circulation of the oil is as follows. The gravity tanks are 30 ft. above the level of the turbine bed. Six-inch pipes lead from these tanks down to the engine-room, where they run its entire length and connect by branches with the four bearings of each turbo-generator. There are two of these oil mains, constituting a ring round the room. The oil, under this gravity head, is forced through the bearings, and returns by the second oil main

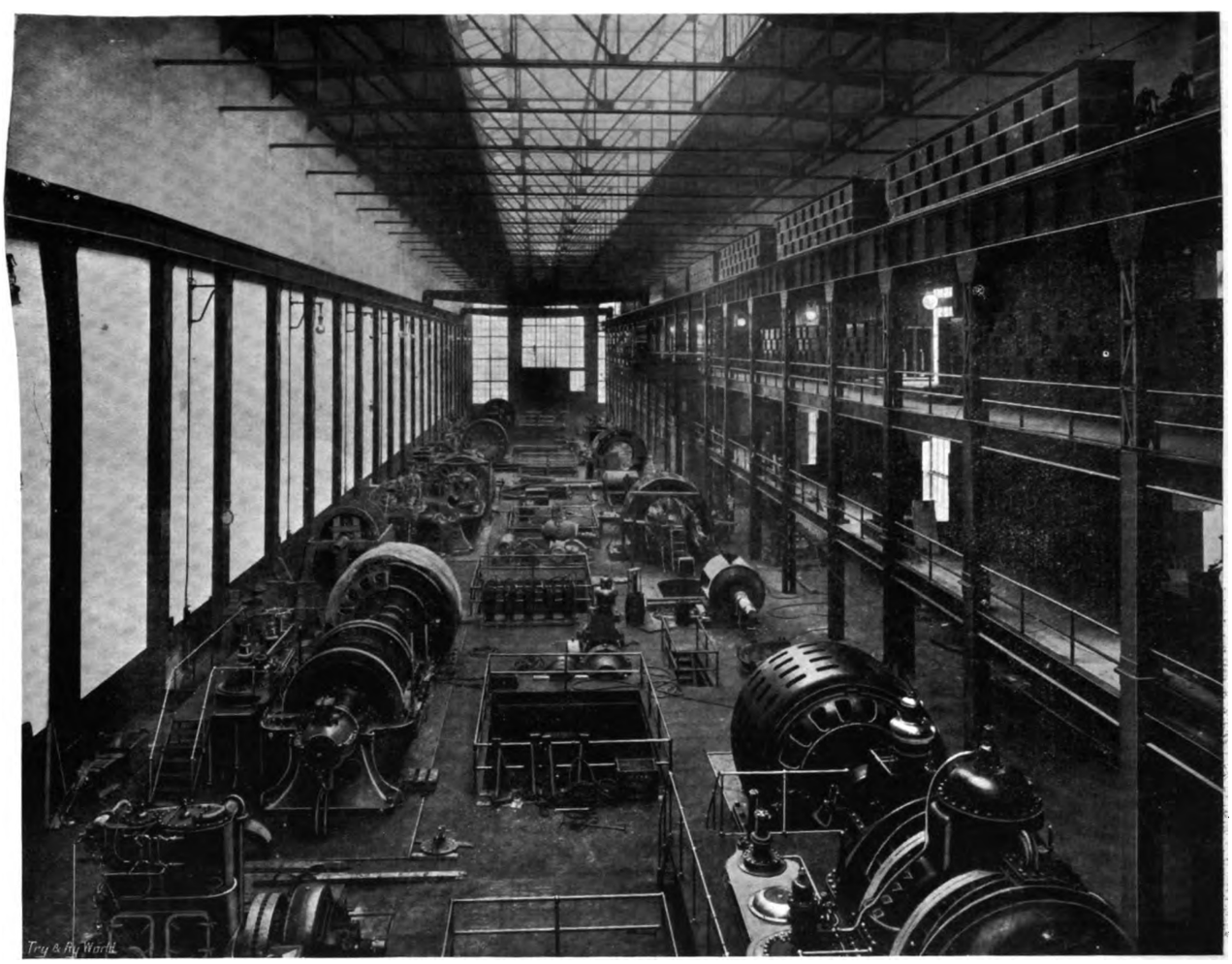

Fig. 26.—Engine Room and Switchboard Galleries.

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by gravity to the tanks in the basement of the oil-cooling building. There electrically-driven centrifugal pumps drive the oil through the coolers and then force it up to the filtering and gravitating tanks on the top floor. From these the process is repeated. Circulating water from the river is pumped through the coolers, and there is a nozzle on the circulating pipe. The cold water is pumped into the chamber, while the oil is forced through brass coils immersed in the water. This is just the reverse arrangement from that employed in surface condensers. Each cooler has about 630 sq. ft. of cooling surface.

THE GREAT SWITCHGEAR.

The design of suitable switchgear to handle properly 57,000 KW. at 11,000 volts constituted one of the most difficult problems in the development of this great station, owing to the dependence of reliable operation upon the switchgear, the impossibility of making experiments on anything like full power, and the lack of precedent in the United Kingdom. Such precedent as there was existed only in one or two large steam power-stations in New York City. In its main features the gear of the Chelsea station follows the general lines of these stations which approach it in power and voltage. The whole of the gear was designed and supplied by the British Thomson-Houston Company, Limited, Rugby.

A brief history of the development of switch-gear for handling with ease the output of large stations at high voltage may be of interest. The chief detail of such gear is the power-actuated oil-break switch. Previous to the construction of the large New York stations, a number of power-actuated oil-break switches of rather primitive form had been in experimental use in several large stations using high voltage transmission. One form of these switches consisted essentially of wooden barrels filled with oil in which a crude form of knife-switch was immersed, all connections and operating gear being taken out through the top of the oil. The relatively good behaviour of these first types under emergency conditions, proved that for large powers the air-break switch was not worth consideration. These primitive switches were then re-designed to the various forms considered the most satisfactory at the present day.

In the form which has been used in the station here described, the large oil barrels have been replaced by metal oil pots, the bases of which form the live contacts. The moving part of this switch consists of an inverted U-shaped rod, the two ends of which dip centrally into two oil pots. The oil pots themselves are electrically connected to the incoming and outgoing

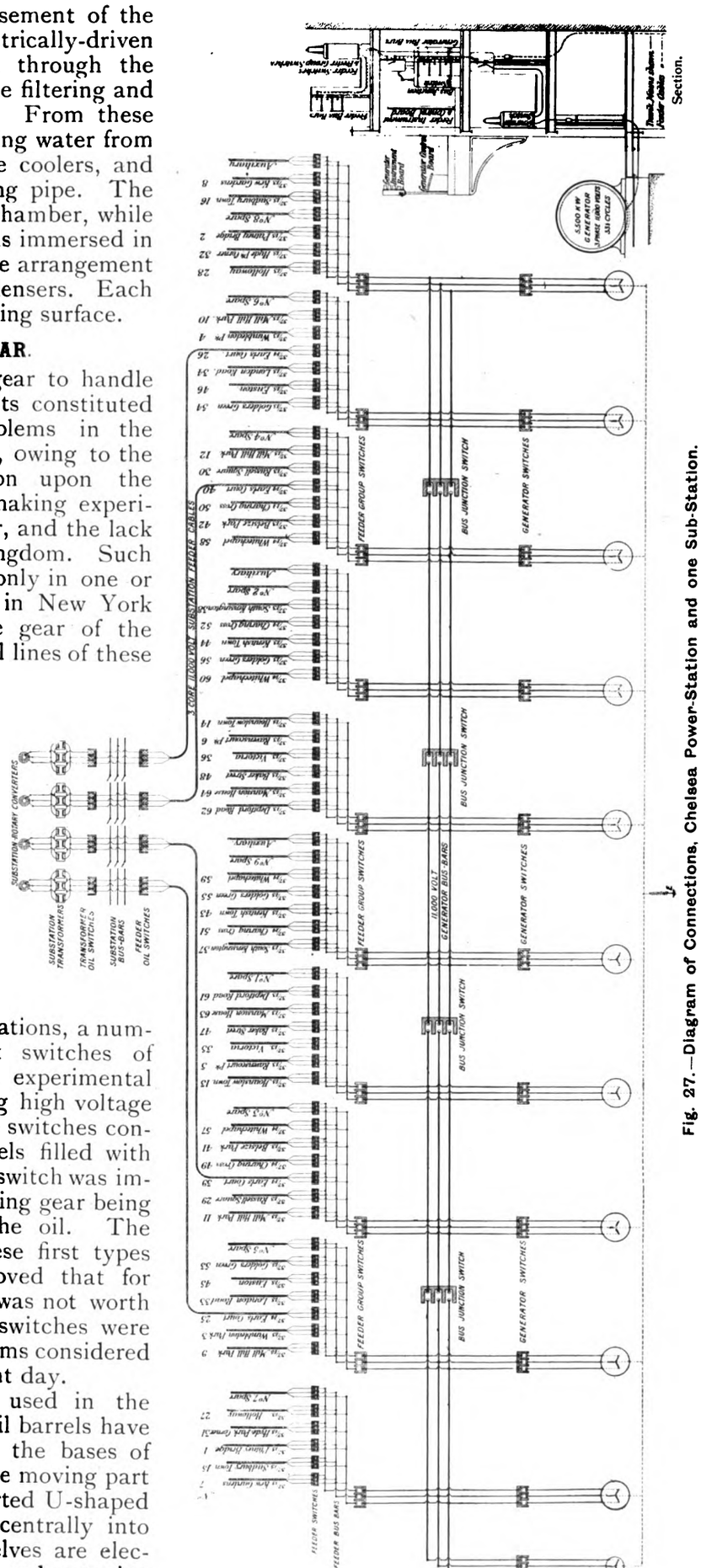

Fig. 27.—Diagram of Connections, Chelsea Power-Station and one Sub-Station.

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cable of one phase respectively. When the U-shaped rod is forced down into contacts in the bases of the oil pots the circuit is closed. When the U-shaped rod is pulled up out of the contacts through the oil the circuit is broken. Insulating stuffing boxes at the top of the oil pots prevent the oil from being thrown out in case the disruption of the circuit raises a high pressure within the oil pot. The advantage of this construction over the previous form lies in the fact that a much smaller amount of oil is used, and this oil is enclosed in a series of metal vessels, and is therefore less likely to spread a serious fire if ignited at any point. Absolutely all the oil is above the points where the circuit is broken, and is therefore available to drown out the arc.

In their original form the switches were actuated by compressed air cylinders, the valves of which were electrically controlled. Pneumatic control has since been superseded by direct electric control, usually by means of a small direct-current motor mounted on each complete three-phase switch. The switches used

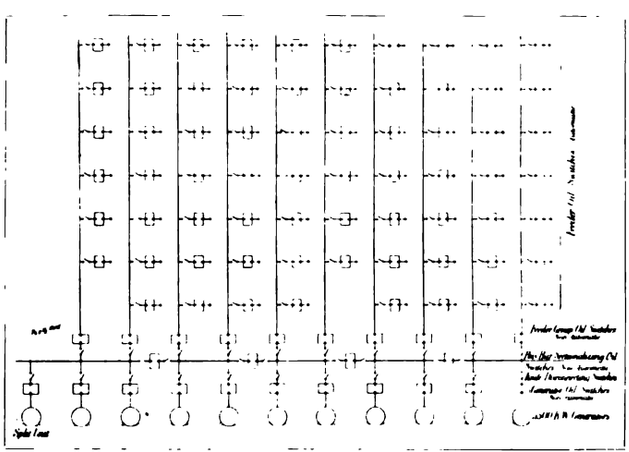

Fig. 28.—Key Diagram of Connections, Chelsea.

in the Lots Road station follow this precedent, and also resemble their predecessors in the distribution of the high-tension parts over a large area, the remote control feature allowing the scattered oil switches to be operated from one central keyboard. The high-tension oil switches—of which there are about 100 complete three-phase sets—are scattered with the corresponding busbars, cables, etc., over three switchboard galleries running the whole length of the station—about 450 ft.—on the Lots Road side, that is, the side of the turbine room away from the river and the boiler room. A general idea of the situation of this gear can be obtained from the accompanying view of the turbine room. (Fig. 26.)

In general, the arrangement is such as to make the high-tension leads as direct as possible; for example, the several generator switches are not grouped together, but are located nearly opposite their respective generators. The oil switches supplying the outgoing lines are also

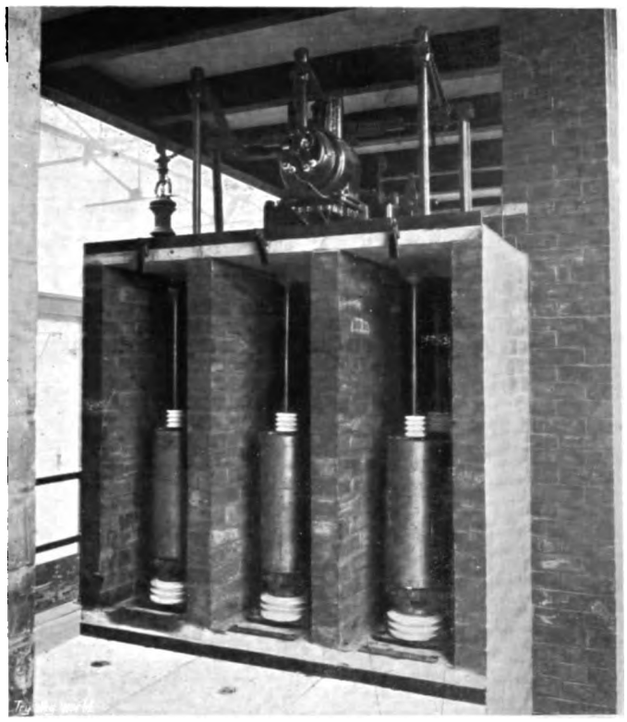

Fig. 29.—Form H 3 Oil Switch at Chelsea Station.

scattered over the length of the house, and are supplied from the main busbars between the several generator switches; thus there is no single busbar carrying the whole station output. The high-tension busbars are not in duplicate, owing to the complications which a duplicate arrangement involves in high-tension work with the isolating barriers, and also owing to the complications in operation which might arise if, for example, the duplicate busbars should be unintentionally paralleled through two or more high-tension transmission lines running to the same sub-station.

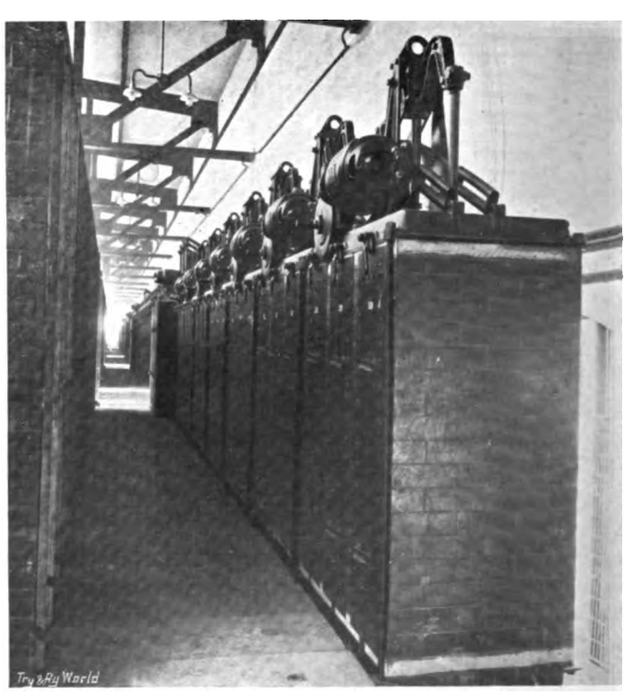

Fig. 30—Line of Form H Oil Switches at Chelsea Station.

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To enable a fault even on the high-tension main busbar to be cleared without suspending service, and to make it possible to inspect, repair, or alter any part of the high-tension main bus, this is divided into five sections by means of four oil switches, as indicated in the accompanying general diagrammatic sketch of connections and key diagram. (Figs. 27 and 28.) To each of the five sections are connected two of the 5,500 KW. main generators, each of which sections is provided with one complete motor-operated three-phase oil switch. From each of the five main sections of the busbar about 13 of the total number of 68 three-phase cables leading to the sub-stations are supplied. Each of the outgoing cables is provided with its own complete motor-operated oil switch, but the connection is not made directly from this feeder

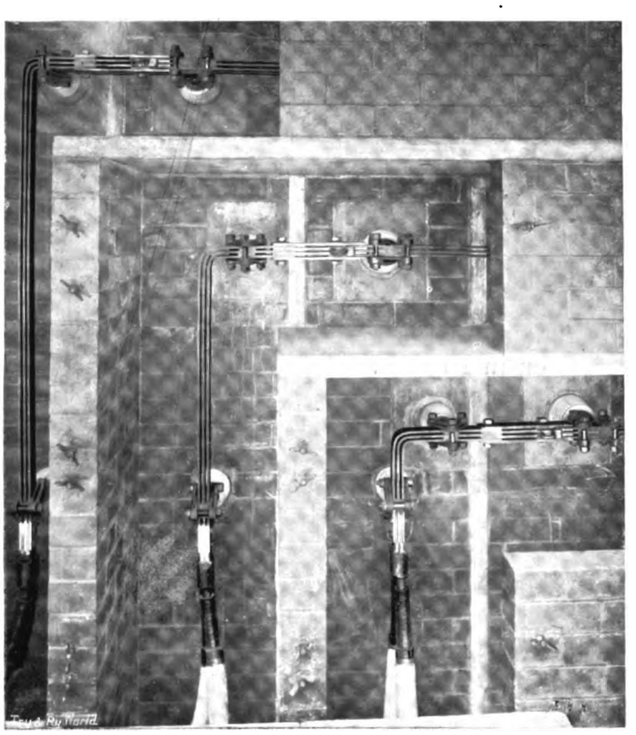

Fig. 31.—Isolating Switches in Power-Station.

switch, as it is called, to the main bus. From each of the five sections of the main bus power is delivered through two "feeder-group" or "group" oil switches, each such switch feeding a short length of busbar, termed a "group bus," from which in turn six or seven feeders are supplied through their respective oil switches. This principle of grouping the feeders was adopted with the object of getting two oil switches in series with each other, so that in case of the failure of one from any cause, the other would be available to open the circuit in case of an emergency. Obviously two complete motor-operated oil switches for each of sixty or eighty feeders would add so greatly to the number of parts and general complication, that the duplication would be of doubtful advantage. A compromise was obtained by putting a single oil switch in each feeder, with a group switch for each six or eight.

Each sub-station is provided with two or more separate high-tension feeders, each consisting of a three-core cable. These feeders supply one high-tension busbar in the sub-station. The several feeders to one sub-station are taken from different sections of the high-tension busbar in the generating station, so that all sub-stations can be supplied through part of their feeders, even with one complete section of the main busbar in the generating station out of service.

The Oil Break Switches.—Each oil switch is enclosed in a fireproof brick and stone cellular compartment designed to prevent the spread of a burn-out in case the oil-switch should for any reason fail. This principle is also carried further by isolating each phase in its own cell with masonry barriers between the cells, the idea being that if one phase should fail, the other two would open the three-phase circuit if the spread of the trouble to them is prevented. The general construction of the switch is shown in the accompanying illustrations (Figs. 29 and 30). The contact rods within the oil are capable of carrying about 300 amperes continuously. This is ample for any one of the outgoing feeders, but is not equal to the load which may come upon any one of the busbar section or group switches. For these cases an auxiliary contact in air is made across the tops of the oil pots, this contact being broken before the contact within the oil pot. These air contacts can be seen in the accompanying face view of one of the busbar section switches. The moving parts of the switch are thrown from the off to the on position or from the on to the off position by means of powerful coiled springs contained within the mechanism above the stone slab which forms a cover to the high-tension parts. When thrown by one spring against the other they are caught and prevented from rebounding by means of a clutch, through which the driving motor immediately takes hold, and supplies the necessary power to complete the compression of the receiving spring. In other words, the moving parts are tossed from one spring to the other, the motor simply serving to make up the losses and complete the stroke. The first throw of either spring is ample to close the switch from the open position, or open the switch wide from the closed position. This feature of throwing the somewhat heavy moving parts from one spring to another gives quick action without violent jars, as one spring cushions the throw of the other.

Each oil switch is connected to the busbars through three knife-blade isolating or disconnecting switches, which are not intended to be opened when carrying current, but can be readily opened when the circuit has first been broken by means of the oil switch. These knife switches are operated by means of long wooden rods

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with hooked ends, which may be engaged in holes through the knife blades. These isolating switches serve to disconnect the live parts of the main oil switch from the busbars for inspection, cleaning, etc., and also make it possible to test the mechanism of any oil switch without connecting the corresponding machine or feeder to the live bars. A set of these knife switches of full busbar capacity, 1,000 amperes, and designed to disconnect a busbar section switch, is illustrated herewith (Fig. 31). The knife disconnecting switches, together with all other high-tension gear, such as main busbars, pilot transformers, main leads, etc., are thoroughly isolated by means of masonry barriers, either of brick or artificial stone construction, as shown in the accompanying photographic views.

The Switchboards.—The high-tension operating and instrument boards are of two types, one made up of the usual vertical panels, the other consisting of an inclined bench-board or table, on which are mounted the handles of the control-gear, and an instrument section, separated from the bench-board by a space through which the operator can glance over the station. This bench-board stands in a projecting bay of the

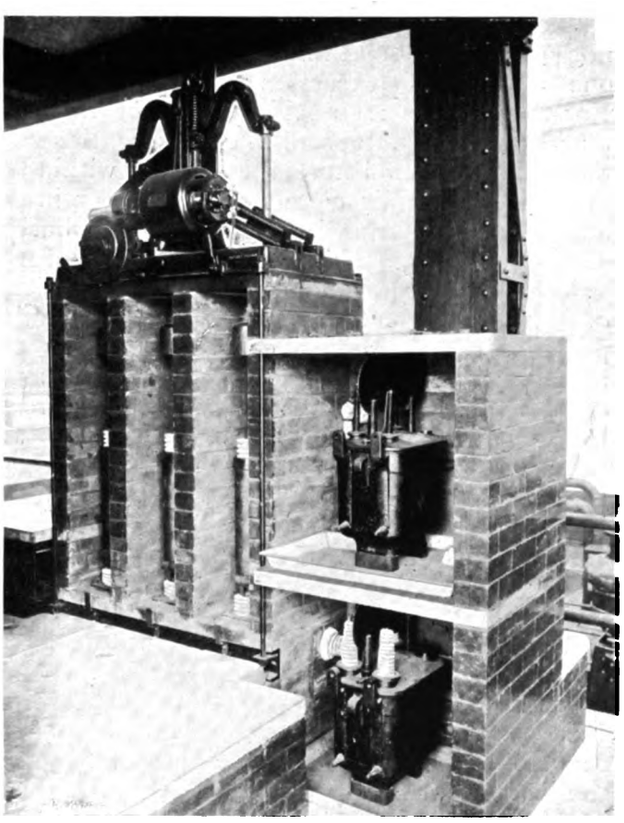

Fig. 34.—Form H Oil Switch and Potential Transformers at Chelsea Station.

second gallery, with the vertical panels immediately behind it, so that the operator has the switchboard both before him and behind him, thus greatly shortening the total length of travel required to control all of the gear. All the machines are controlled and measured on the inclined bench-board facing the station and on the corresponding instrument panels, while all the outgoing feeders are handled on the vertical panels; thus when the operator faces the station he has the control of his machines in front of him, and of his feeders behind him. Through

Fig. 33.—Main Rheostats, Motor Operated.

the open space between the bench-board and the instrument panels above it the operator can look out over the station. A view of the boards is given in Fig. 32.

On account of the large size of the field rheostats necessary to handle the excitation of the large generators and particularly on acccunt of the high temperature at which these rheostats would run if crowded together, it has been necessary to locate them at some distance from the operating board, for which reason their contact arms are motor driven. A small controller on the bench-board panel for each generator serves to start, stop, or reverse the direct-current motor driving the corresponding field rheostat. Limit stops on the rheostat dial also serve to cut off the current of the motor, in case the operator attempts to run the contact arm beyond the limits of the dial. In the accompanying view of the end of the galleries of the station (Fig. 33), these motor-operated rheostats can be seen above the auxiliary switchboard. The main field discharge switch, which is of the single-pole type, is, however, mounted directly on the generator panel in the controlling bench-board. Each generator panel is therefore equipped with:

1. One controlling hand switch for main oil switch.
2. Two indicating lamps to show whether the main oil switch is in open or closed position.
3. One field discharge switch.
4. One field rheostat motor controller.
5. One synchronising receptacle.
6. One signal push switch to turbine position.
7. One controlling switch for turbine governor motor.

By means of the last device the speed of the turbine may be adjusted in order to bring it into synchronism with the other machines, also when

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the machines are in parallel the division of the load may be adjusted from the switchboard.

For each generator there also the following instruments:

Three main ammeters.
One main voltmeter permanently connected across one phase by means of a potential transformer.
One power factor indicator.
One field ammeter.
One integrating watt-hour meter.

The latter is of the single-phase type with a potential derivation of proper phase relation to give correct readings on one phase of the three-phase circuit. On account of the fact that the load on this system will be almost entirely of a perfectly balanced character, the complications of polyphase watt-hour meters designed to read properly on unbalanced circuits are not considered warranted. Each generator is also equipped with one reverse-current relay designed to light up an alarm lamp but not to operate the corresponding oil-switch automatically. The object of this device is to give the switchboard attendant instant notice on the proper panel if any generator fails. Automatic operation of the generator switches is avoided owing to the liability of excessive out-of-phase oscillating cross currents when a heavy fault occurs outside on the network. These momentary rushes of cross current would pull out the generators if equipped with reverse current automatic release, and suspend the service, a result which is to be avoided on this system except in the very last extremity.

The highest voltage on the switchboard or benchboard is the 125 volts of the exciter and switch-operating circuits. All alternating potentials for voltmeters, wattmeters, synchronising, etc., are derived from potential transformers (Fig. 34), having a ratio of 100 to 1, thus giving 110 volts when the line voltage is 11,000. One terminal of the secondary circuit of each of these potential transformers is earthed on a ground busbar which circulates through the extra high-tension gear for the purpose; thus if a high-potential instrument transformer should by any chance break down between the primary and secondary coils, the breakdown current would be carried off to earth without raising the potential of the secondary circuits supplied from the transformer. Similarly all ammeters, overload relay coils, series coils of wattmeters, etc., are supplied from series or current transformers giving a secondary current at full load of 3½ amperes at a pressure of roughly 10 to 12 volts.

Fig. 32.—Machine and Feeder Switchboards, Chelsea Station.

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The secondary circuits of these current transformers are earthed similarly to those of the potential transformers above mentioned. The current transformers are substantially designed with a jointless magnetic circuit requiring negligible magnetising current, thus giving them a very accurate and uniform ratio of secondary to primary amperes throughout their whole load. They are also of ample power to furnish current for either one indicating instrument alone, or two indicating instruments in series with an integrating instrument and relay without appreciable change of ratio; thus any 40 to 1 current transformer is interchangeable with any other 40 to 1 current transformer, regardless of the number of instruments for which it furnishes current within the limits reached in this station and without recalibration of the instruments.

The current and potential transformers are, of course, conveniently located to the high-tension leads to which they are connected. To connect these transformers and the oil switches with the central switchboard a large number of small leads are required. These are all run in extra heavy screwed Simplex pipe, largely of the 1½ in. size. These pipes were laid on top of the gallery floor joists before the flat concrete-arch floors were put down. Thus the pipes have been buried out of reach of trouble in the concrete. The piping system was very thoroughly worked out to carry each particular pipe as close as possible to the individual device, such as current or potential transformer at one end, and the corresponding controlling switch, relay, or instrument which it should reach at the other end. This was done entirely without main cross-over boxes, into which it is sometimes customary to bring a large number of pipes, and in which the wires can be generally crossed over to avoid the labour of laying out each pipe accurately from start to finish. The pipes themselves form a number of crosses in the concrete, due largely to the fact that although a given sub-station is supplied from sections 1, 3, and 5 for example, the three controlling switches, ammeters and integrating watt-hour meters for the feeders of this particular sub-station are grouped together on one panel of the feeder board. The iron armoured tubing takes care of all of these crosses of controlling and instrument wiring without any danger of interference between circuits.

In answer to objections that have been raised to burying such iron-armoured tubing in the concrete on the score that it would be difficult or impossible to get at the wiring in case of severe burn-outs which might injure the pipe, it may be said that considerable experience with this form of construction has shewn that burn-outs when they do occur do not injure the pipe, and that the burned out wires can readily be drawn out and new wiring installed even where the piping is entirely inaccessible. The use of high-tension enclosed glass-tube fuses in the primary leads of the potential transformers prevents any considerable rush of power through them into the piping in case of a fault. The current transformers cannot of course be similarly protected, but the solid earth connection of one secondary terminal takes care of any possible transformer breakdowns without injury to the piping system carrying the secondary conductors.

The Automatic Protecting Devices.—As noted above, the main generator oil-switches are non-automatic and are closed and opened by hand control only. The busbar sectionalising switches and the group switches are similarly non-automatic. The individual feeder switches are the only automatic high-tension oil switches in the station. These are equipped with overload relays of the adjustable time-limit type, the time feature being obtained by an air dash so designed as to allow the relay contacts to close instantly in case of a short circuit, while a moderate overload will only close the contacts after an adjustable time-limit of several seconds. To provide for operation with the neutral of the high-tension generators earthed, and to take care of all possible breakdown between any feeder conductor and the lead sheath, a relay is connected in each of the three phases of each outgoing line, the three relay contacts being connected in parallel to supply the motor of the corresponding oil switch; thus a breakdown to earth on any one of the three phases trips out the whole feeder at the generating station end. The relay contacts for all the feeders are supplied through what might be termed an alarm relay, which in turn rings a gong in case any high-tension switch trips out automatically; this alarm relay is inactive when the high-tension switches are opened by hand control.

To enable the operator readily to find which one of his many feeders has tripped out automatically, the alarm relay also illuminates one of ten alarm lamps, indicating to which group the faulty feeder is connected.

The oil switch gear is designed in accordance with the modern idea that the power to be broken by any one oil switch cannot be determined by the rating of the corresponding machine or line, but under emergencies may rise to the whole short circuit output of the station. This idea is such an important one that a little further explanation may be warranted in spite of its obviousness. In the case of a fault upon a high-tension feeder which may be rated at 2,000 KW., and may never normally carry more than that, the power to be broken by the feeder oil switch will not be limited to 2,000 KW., but will be whatever the whole station can generate on short circuit, together with considerable power that will be momentarily thrown back from all synchronous machinery on the system by virtue of its inertia and excitation. It is almost needless to say that the high-tension oil switches for this station have not been tested on a solid short circuit of 50,000 KW. of machinery, but similar switches have broken faults on

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systems nearly as large without damage to the switchgear.

In accordance with modern practice, no charging devices have been installed for gradually applying voltage to the high-tension three-core cables supplied from this station. It is argued that with oil-break switches no charging devices are necessary, as the harmful effects of throwing a cable directly into circuit are said to be due to the air arc which strikes across between the contacts of an air-break switch for a fraction of a second while the switch is approaching the closed position. These effects are not found with an oil-break switch, which apparently does not allow the current to strike across its contacts until these are so close that the current persists without an intermittent make and break at each alternation.

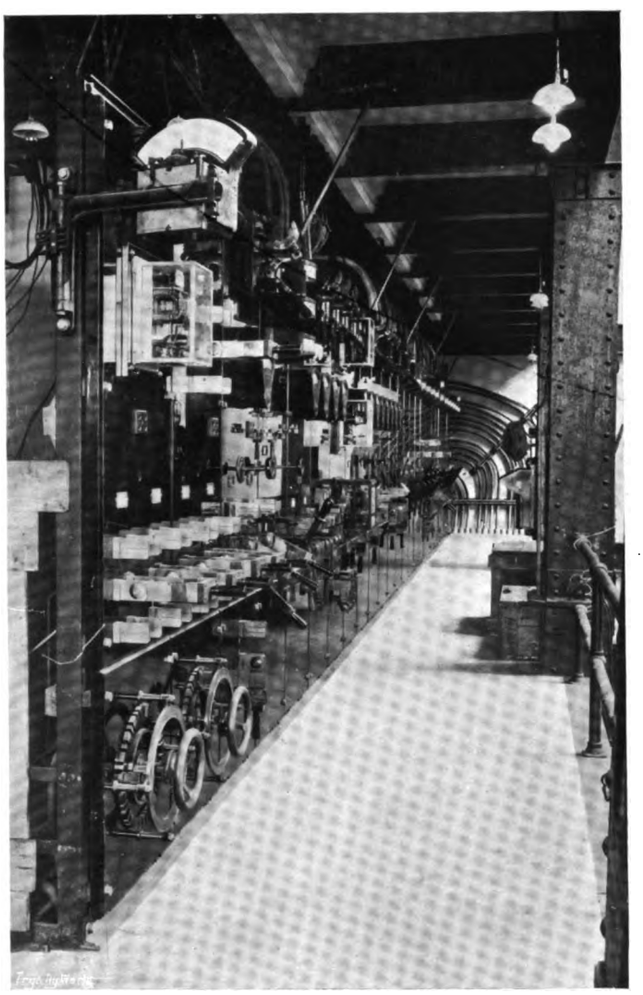

Fig. 35.—Switchboard for Auxiliary Plant.

The connection of the neutral of the generators is made through a resistance of six ohms, thus limiting the flow of current in case of a solid earth on any phase to about 1,000 amperes. This is ample to pull out the faulty feeder, but will not drop the synchronous machinery out of step as would a solid short circuit.

The Auxiliary Switch-gear.—For handling the exciters, and for supplying power to a large number of motor-driven auxiliaries scattered through the station, which require approximately 100 motors, there is mounted in a gallery at one end of the station a switchboard as large as that of the average power-house, and capable of handling fully as much power. A view of it is given in Fig. 35. The exciter system consists of four 125 KW. 125-volt compound-wound engine-driven generators. To avoid any chance of short-circuiting across the exciter busbars the exciter panels are single pole, the other polarity, together with the equaliser, being handled by switches mounted on pedestals adjacent to the exciters; thus only one polarity of the exciter system is carried to the exciter switchboard gallery.

For supplying the direct-current motor-driven oil switches, motor-driven field rheostats, and other switch-gear motors and control circuits, two 125-volt storage batteries have been installed, the duplication being for the purpose of allowing one storage battery to be carrying the load while the other is charging. These batteries may be charged from a 125 KW. motor-generator set, taking power from the three-phase side. The motor of this set is of the synchronous type, and at the time of writing this machine is being used reversed, taking power from the direct-current side and generating power on the alternating-current side for extra high potential tests. Suitable end-cell switches are provided to keep up the delivered voltage as the battery discharges. An emergency connection is also provided so that the storage batteries may be charged from one or more of the exciters in case the synchronous motor-generator set becomes crippled. The auxiliary board also provides for supplying a number of direct-current crane motors from either the motor-generator set or, in cases of emergency, from the exciters. Like the high-tension bus, the exciter bus is sectionalised into two parts, so that continuous service can be given by the plant, and alterations can be made on either part of the bus at times of light load.

For the supply of the eighty-odd induction motors driving air and circulating pumps, stokers, conveyors, etc., throughout the station, three banks of air-blast step-down transformers have been installed, each bank consisting of three 167 KW. transformers delivering 220-volt current when supplied at 11,000 volts. Two of these banks, aggregating 1,000 KW., will be required at times of heavy load, the third being a reserve. On the high-tension side these are supplied from three different sections of the main high-tension busbars through the usual group switches and individual transformer bank switches, the controlling switches of the latter being mounted on the auxiliary board. On the low-tension side these three banks of transformers feed a 220-volt bus, which again is not in duplicate, but is sectioned into two parts, so arranged that one bank of transformers feeds each half of the bus, and

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the third bank can be connected to either or both. These low-tension connections are made by means of heavy air-break lever switches. From this 220-volt low-tension bus lead-covered feeders are supplied through automatic oil switches of the hand-operated type mounted on the back of the panels, and distribute the current throughout the whole station, with individual motor switches and starters mounted adjacent to the motors. The oil switches in these low-tension feeder circuits are automatic and fitted with overload release without time-limit attachments.

The whole work of erecting the power-station and installing the plant has been under the supervision of Mr. J W. Towle, resident engineer for the Underground Electric Railways Company, while the general design and installation of the electrical equipment in the building have been under the charge of Mr. S. B. Fortenbaugh, electrical engineer of the Company.

HIGH-TENSION CABLES.

The task of describing the great system of high-tension cables from the power-station to the sub-stations on the District Railway is rather a complicated one, the more so because the work was split up among several manufacturers, who had sections dotted all over the system. The cables, of course, do not extend to the various termini of the railway, but stop at the sub-stations nearest these termini. A careful reckoning of the various distances and of the number of cables on different routes shows that the total distance traversed by high-tension cables is about 31 miles, and that the total length of the cables employed is no less than 285 miles. About 78 miles of these cables, however, which are laid between Lots Road and Earl's Court and from Earl's Court to Charing Cross are merely accommodated, their purpose being to supply the Great Northern and Brompton, the Baker Street and Waterloo, and the Charing Cross and Hampstead Railways. The above total figure of 285 miles includes, accordingly, the Great Northern and Brompton Railway cables from Lots Road to Earl's Court, whence they will be continued on that railway when completed, and the Baker Street and Waterloo and the Charing Cross and Hampstead Railways cables from Lots Road to Charing Cross, whence they will be continued along these two railways. It may be mentioned that when the tube railways are completed they will require in all 156 miles of high-tension cables. This includes the 78 miles mentioned above. The total length of such cables from the power-station to all the railways fed will then be 363 miles.

The greater part of the cables was supplied by the British Insulated and Helsby Cables, Limited, the total length being about 202 miles. Out of this, the lengths between Lots Road and Earl's Court amount to 65 miles; from Earl's Court to Charing Cross, 110 miles; and the remaining lengths are laid on the stretches from Putney Bridge to Wimbledon Park, Turnham Green to Kew Gardens, Hanger Lane to Sudbury, and Whitechapel to East Ham. The work between the power-station and Earl's Court first claims attention.

In the latter part of 1903 and the beginning of 1904 the work of laying the ducts over this distance, which is slightly more than a mile, was carried out. Callender's Cable and Construction Company were entrusted with it. The route passes along several streets, one of them a new one running through what had hitherto been private ground, and the line of ducts finally reaches the District Railway by Warwick Road, at the west end of Earl's Court station. The trench which had to be dug was about six feet wide and from seven to sixteen feet deep, according to underground pipe obstructions, while at man-holes at the cable joints it had to be made much wider. Doulton's earthenware octagonal ducts were used, a length of one being shown in Fig. 36. Each section is 24 in. long and 5¼ in. outside and 4 in. inside diameter. They were all examined to see that they were free from internal roughness and well glazed. The total number of ducts is 64, arranged in two groups, 32 a side. A concrete bed 3 in. thick was laid in the bottom of the trench, extending 3 in. outwards on each side beyond the space to be occupied by the ducts. The bed was then floated with cement mortar, and the first layer of ducts, spaced apart somewhat, was laid down. The lengths were jointed by butting the ends together and surrounding the joint with coarse canvas. The spaces between the ducts were then filled with concrete, and a bed prepared for the next layer, and so the work went on to the completion effected by covering the top layer of ducts with 3 in. of concrete and filling in the trench. The difficulties at some places with gas, water, and other mains were considerable.

Fig. 36.—Doulton Duct for Cables.

Each manhole has a central dividing brick wall, 9 in. thick, which is shown in Fig. 37. The chambers are about 18 ft. long by 11 ft wide, and are covered by steel girders which support the roadway. The large manholes where the ducts bend down to the railway are entered by underground staircases. The manholes and the work of laying the ducts are illustrated in Figs. 37 and 38.

The British Insulated and Helsby Company next carried out the task of drawing in and joining the cables. The contract included bringing the cables through the ducts which pass through the foundations of the power-station

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building, and taking them up to the back of the switchboard, where they are jointed through three-way connection boxes to the isolating switches, and thence to the rubber-insulated cables coming from the switchboard. The arrangement of the cables led up the face of the wall is symmetrical and very neat.

The cables were drawn through the ducts in the usual way from the manholes, and in these chambers they are hung on cleats on the walls, half the cables going round one side and half round the other. The joints of adjoining cables are staggered. The total number of cables drawn in was 56—28 on each side, leaving four spare ducts on either hand. In this, as in all the other cases along the line of the railway, only half of the cables will be used at a time, the other half being in reserve in case of accident. The whole high-tension distributing system is in duplicate, so that even if one system of cables were disabled the railway could be worked by the other.

All the cables for this transmission line, as well as those along the railway, were made to the specification of the Underground Electric Railways Company, and save for some minor allowable differences are similar, by whatever makers they have been supplied. They are all three-core, paper-insulated, and lead-covered, the lead sheathing being of exceptional thickness. Those supplied by the British Insulated and Helsby Company are of three sizes, but all have 37 copper wires in each core, the wires varying, however, in gauge. The section of core used by this company is that known as the cloverleaf. The following gives the details:

	Size of Cable—L.S.G.		
	No. 37/15.	No. 37/14.	No. 37/13.
Sectional area of each conductor sq. in.	·15	·19	·25
Maximum resistance of each conductor per 1,000 ft. at 60° F.—Ohm	·054	·044	·034
Thickness of insulation between conductors	·4375 in.	·4375 in.	·4375 in.
Thickness of insulation between conductors and earth	·4375 in.	·4375 in.	·4375 in.
Thickness of each insulation paper	·005 in.	·005 in.	·005 in.
Thickness of lead covering	·1875 in.	·1875 in.	·1875 in.
Approximate overall diameter of finished cable	2·65 in.	2·78 in.	2·94 in.
Approximate diameter of finished joints	4 in.	4·2 in.	4·4 in.
Approximate maximum insulation resistance per mile at 60° F.—Megohms	500	500	500

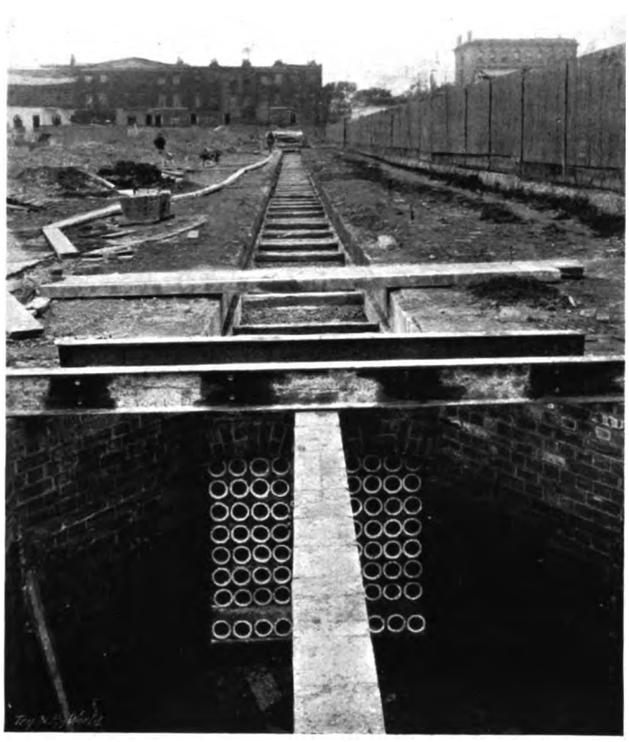

Fig. 37.—Manhole and Transmission Line along a New Street.

Fig. 38.—Manhole in Transmission Line under Construction

At the factory these cables were tested with a pressure of 33,000 volts, alternating three-phase current, $33\frac{1}{3}$ cycles per second, being three times the working voltage. After they were laid and jointed, they were subjected to a 22,000 volt test for a period of one hour.

The 110 miles of cables along the sides of the District Railway between Earl's Court and Charing Cross form an interesting piece of work. As far as South Kensington there are 15 cables on each side, thence to Victoria 14, and thence to Charing Cross 13. To the walls of the tunnel are fastened wall-plates, each of which carries on its face in a vertical row as many small brackets as there are cables to be carried. Over the whole system there are about 90,000 of these brackets. The wall-plates are spaced about 12 ft. apart, and the brackets support rolled-steel

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troughs of J section. This troughing is for the purpose of covering and aiding in supporting the cables. The Board of Trade suggested the troughing, and the Underground Railways Company also considered that something of the kind was needed, owing to the fact that lead-covered cables supported in 12 ft. spans sag unequally, and without the troughing they might sometimes have touched each other. Spans of 12 ft. were, however, necessary over long distances, owing to the pilaster construction of the walls of the tunnels. About 1,250 tons of this steel troughing were required; half of it was supplied by the Sir Hiram Maxim Electrical Engineering Company, most of the rest by Messrs. William Bain and Company, Coatbridge, and a small portion by Messrs. Armstrong, Stevens and Son, Birmingham. When in its normal position on the brackets, the longer leg of the J is outermost, and it fills all the space up to the base of the trough above. The trough is opened for laying the cable in it by turning the longer leg downwards, so that it lies on the bracket, and the hollow of the trough

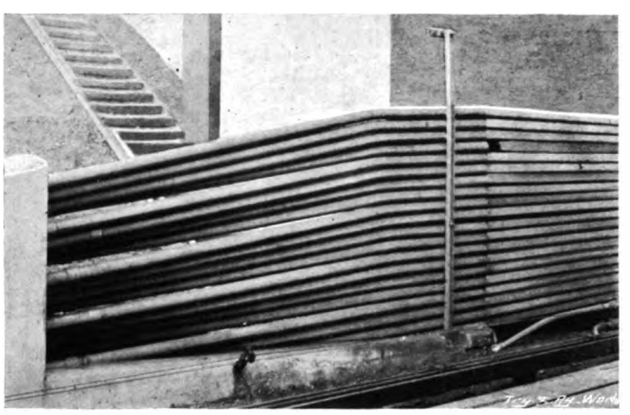

Fig. 39.—Cables Going Underground.

faces outward. The cable having been laid, the trough is turned up again and secured by small pins. Troughs are provided for electric lighting and other cables, as well as for the high-tension distributors. This troughing may be seen on the right in Fig. 39, which also shows the cables going underground at Earl's Court Station.

The work of erecting the cables in the tunnels was one of considerable difficulty, owing to the shortness of the time in the early morning during which no trains are running on the railway. One of the conditions imposed on the contractors was that the railway traffic was on no account to be interrupted. The longest interval between trains was 2¾ hours, except on Saturday nights when there was about 4 hours. The cables on their drums were taken on wagons along the railway in the tunnel, and in regard to the part now under consideration between Earl's Court and Charing Cross the point of despatch was Earl's Court. A train of the wagons ready to start is shown in Fig. 40. When a train was taken down into the tunnel to the spot where erection work was to be carried on, the end of a cable was taken off its drum and securely held, while the locomotive slowly hauled the train forward. The drum revolved, unwinding the cable, and as it came down alongside the track the workmen stowed it into the troughing. Other

Fig. 40.—Train Load of High-Tension Cables.

men closed up the troughing behind in the way already described, and opened up the next length. The men became so expert in the work, that a whole cable, over 500 ft. in length, could be unwound and placed in the troughing in about ten minutes. Then the next cable drum would be tackled, and so on. Out of 110 miles of cables on this section 106 miles were laid in 540 hours. This is only 54 working days of 10 hours each, but owing to the short working time the 540 hours were spread over a period of six months ending in November last. The average working time possible was about 19 hours a week. The way in which the cable joints are staggered is shown in Fig. 41. The joints were made in the British Insulated Company's usual way, and insulated with tape boiled in rosin oil. They were, however, made with unusual rapidity, two being completed in three nights of 3¾ hours each.

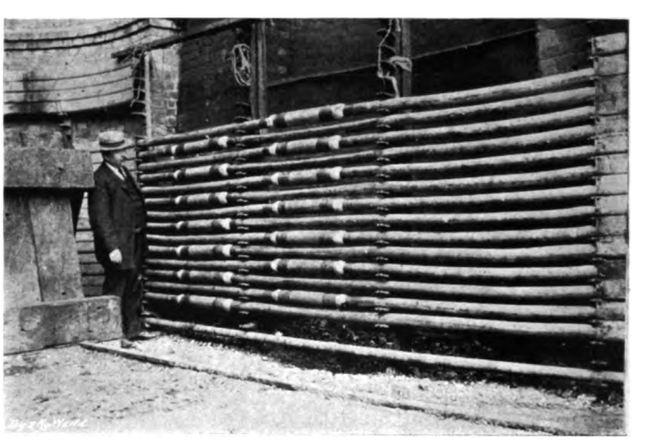

Fig. 41.—Cables Mounted on Wall, Showing Joints.

On the Whitechapel to East Ham section the work was of a similar character, but small in amount, as only two cables are required there, totalling about 11 miles.

At all passenger stations, except sometimes in

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the case of those which have island platforms, the cables are brought down and carried along under the platforms in stoneware ducts after the manner of the Lots Road-Earl's Court transmission line. Telephone, lighting, and signal cables are also carried under the platforms in ducts, the total length of which under tunnel platforms is about 38 miles.

On the Putney Bridge to Wimbledon Park and the Turnham Green to Kew Gardens sections, there are only two cables, provided and laid by the British Insulated Company, and these total about nine miles in length. The same company's work on the Sudbury section also embraces two cables some seven miles long in all, but these were installed by the Underground Railways Company. All these cables are on open portions of the railway, where there are no tunnel walls, and the cables are accordingly laid underground in ducts, sometimes alongside the railway and sometimes in the six-foot way. It may be mentioned here that alongside the open portions of the railway and under the tunnel platforms there are no less than 90 miles of ducts carrying high and low-tension and other cables. Some of them have been supplied by Messrs. Doulton, and some by Messrs. Stanley Brothers, Newington. At the man-holes, which are about 12 ft. long on the open portion of the railway, there are two draw-pits which are not opposite one another, so that the cable joints are well staggered. Mr. W. A. Wilson superintended the whole installation work for the British Insulated Company.

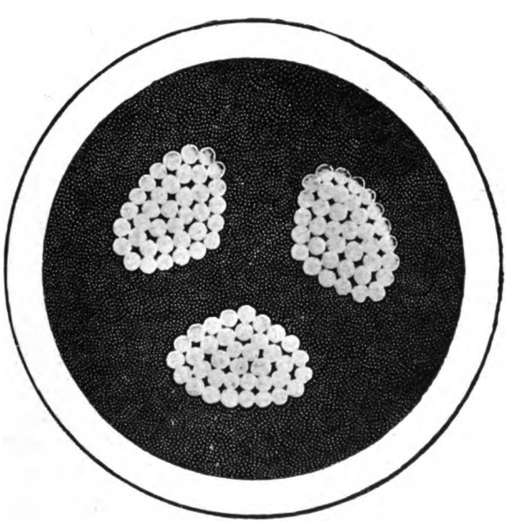

Fig. 43.—Full Size Section of High-Tension Cable.

The sections over which Callender's Cable and Construction Company supplied and laid high-tension cables are those from Mill Hill Park to Ravenscourt Park, Hammersmith to West Kensington, Mill Hill Park to Hounslow, and Mill Hill Park to Hanger Lane. The total distance is about 8 miles, and the length of cables over 40 miles. These cables are of two sizes, those having each core of ·15 sq. in. sectional area, and those with a ·25 sq. in. sectional area per core. The conductivity of the copper is not less than 99 per cent., according to Matthieson's standard. The Manila paper dielectric is thoroughly impregnated with fine bitumen and oil prepared for the purpose. The cores are wormed together with a long lay and made up circular with paper packing. They are then passed through a wax and bitumen compound, and the outside lead sheath is made direct on the cable under hydraulic pressure. The insulation tests were the same as those already described. The cables on the sections above-mentioned are drawn into glazed earthenware pipes 3½ in. internal diameter, the pipes being laid in concrete. Draw-pits are situated along the line of route, the minimum distance between them being about 253 feet and the maximum distance about 572 feet. The average distance is between 300 and 400 feet.

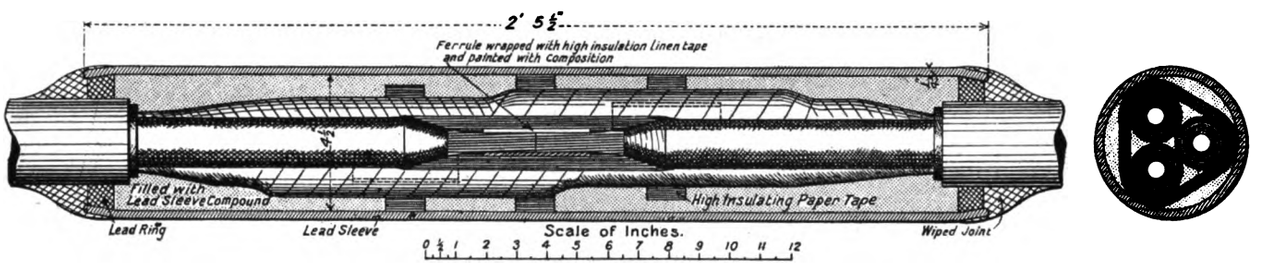

Fig. 42.—Method of Making High-Tension Cable Joint.

The detail of the cable joints made in these pits is of interest, and it may be followed by reference to Fig. 42, which shows fully the arrangements for one of the three cores and indicates the similar fixings for the others. The lead and insulation of each cable is cut back to the distance shown in the drawing, and the ends of the three copper cores of each cable are then cut so as to butt solid against each other. The cores are cut in such a manner that the joints are "stepped" as shown. Over the ends of the copper cores are then slipped copper ferrules, which are sweated on. These ferrules are then lapped with special high insulation linen tape and painted with composition. After each of the three joints has been made, three rings of high insulation tape are wrapped round to keep the cores in their proper position. A lead sleeve, which has been previously slipped over the end of one of the cables, is then placed in position

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and wiped down on to a lead ring at each end. This lead sleeve is filled up solid with special lead sleeve compound, and the hole through which the compound has been poured is then sweated solid. This description of joint practically applies to the other makes of cables also.

The cables are drawn in over nearly the whole of the route, but at certain places where there is no room in the tunnel for the conduits, and also over all bridges, the cables are laid in rolled steel troughing, which is cleated along the wall, as described previously.

W. T. Henley's Telegraph Works Company supplied and laid the cables from Earl's Court to Putney Bridge sub-station, a distance of about two miles. There are four cables running this distance, two of them having cores of 37/15 each and the other two having cores of 37/13 each. The construction and jointing are similar to those already described. Fig 43 is a section, actual size, of the 37/13 cables. On part of this route the cables are mounted on side walls of the railway, and on the rest they go underground in ducts.

The cables on the remaining sections—namely, those from Ravenscourt Park to Hammersmith, from West Kensington to Earl's Court, and from Charing Cross to Whitechapel, a total distance of between four and five miles—were provided and erected by the Electrical Company. The aggregate length of these cables is over 32 miles. On the first and second of these sections there are six cables on each side of the railway. In regard to the third, four feeders run along each side from Charing Cross to the Mansion House. There one drops off on each side; the remaining six are carried as far as St. Mary's, where two more end; the remaining four go on to the Whitechapel sub-station.

The whole of the high-tension cable work constitutes the largest installation of 11,000-volt cables that has ever been undertaken in this country. The general charge of the design and installation was in the hands of Mr. Fortenbaugh.

SUB-STATIONS.

There are in all 15 sub-stations on the District Railway and the lines over which its trains run, exclusive of the Metropolitan Railway part of the Inner Circle, which is separately fed by the Metropolitan Company's station at Neasden. Nine other sub-stations are being provided for the tube railways associated with the Underground Electric Railways Company, making in all 24 sub-stations fed from the Lots Road power-house. Their positions may easily be found on the accompanying map. Those for the District Railway and connections, taken in order from west to east, are:

Sudbury.	Earl's Court.	Charing Cross.
Hounslow.	Wimbledon Park.	Mansion House.
Kew Gardens.	Putney Bridge.	Whitechapel.
Mill Hill Park.	South Kensington.	Campbell Road.
Ravenscourt Park.	Victoria.	East Ham.

The sub-station buildings, which have been erected by various contractors, are, with the exception of the one at Charing Cross, very similar in construction, and the type and general arrangements are shown in the drawings of the one at Mill Hill Park (Fig. 44). They are plain and substantial brick buildings, open from floor to roof internally, and well lighted by large windows. Below the ground level is a basement for cables, etc. Along one side runs a gallery, on the top of which the transformers and high-tension busbar compartments are erected. In front of the high-tension wall come the switchboards, and between the back of this wall and the outside wall of the building are the high-tension isolating switches, the 11,000-volt cables coming in on that side. The main floor space is occupied by the rotary converters, and at either end room is found, in the one case for blowers supplying the air-blast for cooling the transformers, and in the other for an air compressor and a small motor generator. The former supplies the compressed air for the electro-pneumatic automatic signalling on the railway, and the latter the low-pressure continuous current which is sent out to the track rails in connection with the same purpose. In every

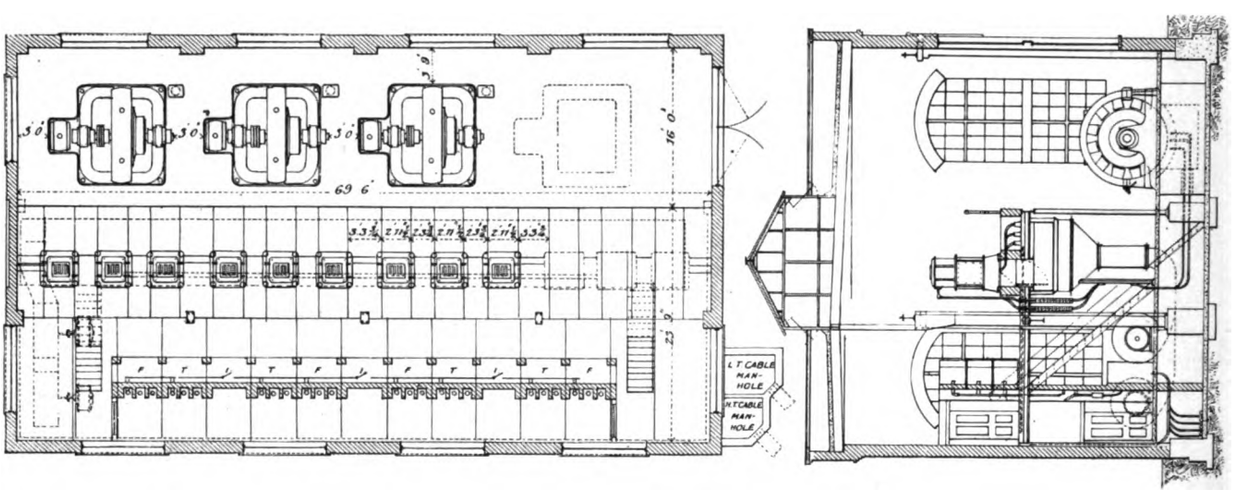

Fig. 44.—Plan and Cross Section of Mill Hill Park Sub-Station.

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case, except Charing Cross, space is left for an additional converting unit to be installed when required.

The Charing Cross sub-station differs from all the rest in the fact that it is entirely underground, but the arrangement of the machinery inside is exactly like that of the others. It is also the largest which is installed at present, though no larger than those at Earl's Court and Whitechapel will eventually be. It is situated immediately to the north of the passenger station at Charing Cross, and is partly below the Embankment Gardens and partly under the end of Villiers Street. It was stipulated that the roof of the structure should be low enough to allow of shrubbery in the gardens to grow on the top of it, so that a good deal of excavation was necessary. The digging out was entirely in soft soil. Means had to be taken to keep out water, and floor, walls, and roof are lined with concrete and asphalte. No vertical supports are needed for the roof, as heavy girders stretch across. Internally the chamber is 69 ft. 4 in. long, 42 ft. wide, and 32 ft. deep. The minimum space between the top of the roof and the surface of the gardens is 4 ft. The floor is some 20 ft. below the level of the platforms of the Charing Cross passenger station, but a passage and an incline were formed from the near platform to an extension of the switchboard gallery. By this entrance the machinery was taken in, and from the gallery it was picked up by the overhead travelling crane and lowered to the floor. A ventilating shaft leads down from the sub-station to the Charing Cross, Euston, and Hampstead Railway, which is almost immediately below, and air can thus pass to and fro through the sub-station between the low-level railway and the District Railway platform. The travelling cranes, which are hand operated, are of 12-ton capacity. In the other sub-stations they are of either 8 or 12 tons, according to the size of the rotary converters.

With two exceptions the sub-stations are built on land adjoining the railway, but at the Mansion House and Victoria this was found impracticable, and these sub-stations are erected immediately above the railway tracks. The buildings are supported on heavy girders. At Victoria the arch of the station roof had to be removed for a short distance to allow space for the building. The rotary converter floor is on the outside street level, and access is obtained from the street. At the Mansion House sub-station, which is similarly constructed, there were obstacles to getting the building up to a sufficient height, owing to the existence of "ancient lights" in buildings on each side of the railway. This prevented the adoption of the standard gallery arrangement, and in this case the transformers have had to be placed on the rotary converter floor.

Scope of the Sub-Station Installations.—The following table shows the number and capacity of the rotary converters in each sub-station, each rotary converter being, of course, supplied with three static transformers, while additional transformers supply low-pressure alternating current for lighting purposes:

Sub-station.	Number of Converters.	Capacity of each Converter.	Total Capacity.
		KW.	KW.
Sudbury	2	800	1,600
Hounslow	2	800	1,600
Kew Gardens	2	1,200	2,400
Mill Hill Park	3	1,200	3,600
Ravenscourt Park	2	1,500	3,000
Earl's Court	3	1,500	4,500
Wimbledon Park	2	1,200	2,400
Putney Bridge..	2	800	1,600
South Kensington	2	1,500	3,000
Victoria..	2	1,200	2,400
Charing Cross	4	1,500	6,000
Mansion House	2	1,500	3,000
Whitechapel	3	1,500	4,500
Campbell Road	2	1,200	2,400
East Ham	2	1,200	2,400
Total	35	—	44,400

The whole of the electrical machinery and switchboards for these sub-stations, as well as for sub-stations under construction for the tube railways, has been supplied by the British Westinghouse Electric and Manufacturing Company. The transformers and converters are of that Company's standard designs, and do not differ from similar Westinghouse machines elsewhere, except that much of the plant is of unusual size. The transformers reduce the pressure of the incoming 11,000 volt three-phase current to about 370 volts, while the converters change it to continuous current at 600 volts pressure for sending out to the conductor rails on the railway. Other transformers are provided in the sub-stations for changing the high-pressure current to 220 volts pressure for a separate circuit for lighting purposes. From the nature of the case the switchboard arrangements in the sub-stations, though of course on a smaller scale, are rather more complex than those in the power-station where for the most part only the high-tension current is dealt with. It is to these switching arrangements that attention is accordingly for the most part directed in the following description.

CHARING CROSS SUB-STATION.

As already indicated, this is in several ways the most important of the sub-stations, and it has further claim to notice from the fact that it will supply power to portions of the Baker Street and Waterloo Railway, and the Charing Cross aad Hampstead Railway, as well as its own section of the District Railway. It will also control the current for working passenger lifts at the adjacent passenger stations of the two tube railways mentioned. A description of the arrangements in this sub-station will accordingly cover, and more than cover, those in the other sub-stations.

Charing Cross sub-station is supplied by four high-tension three-phase feeders, and sends out the converted energy through twenty-four cables

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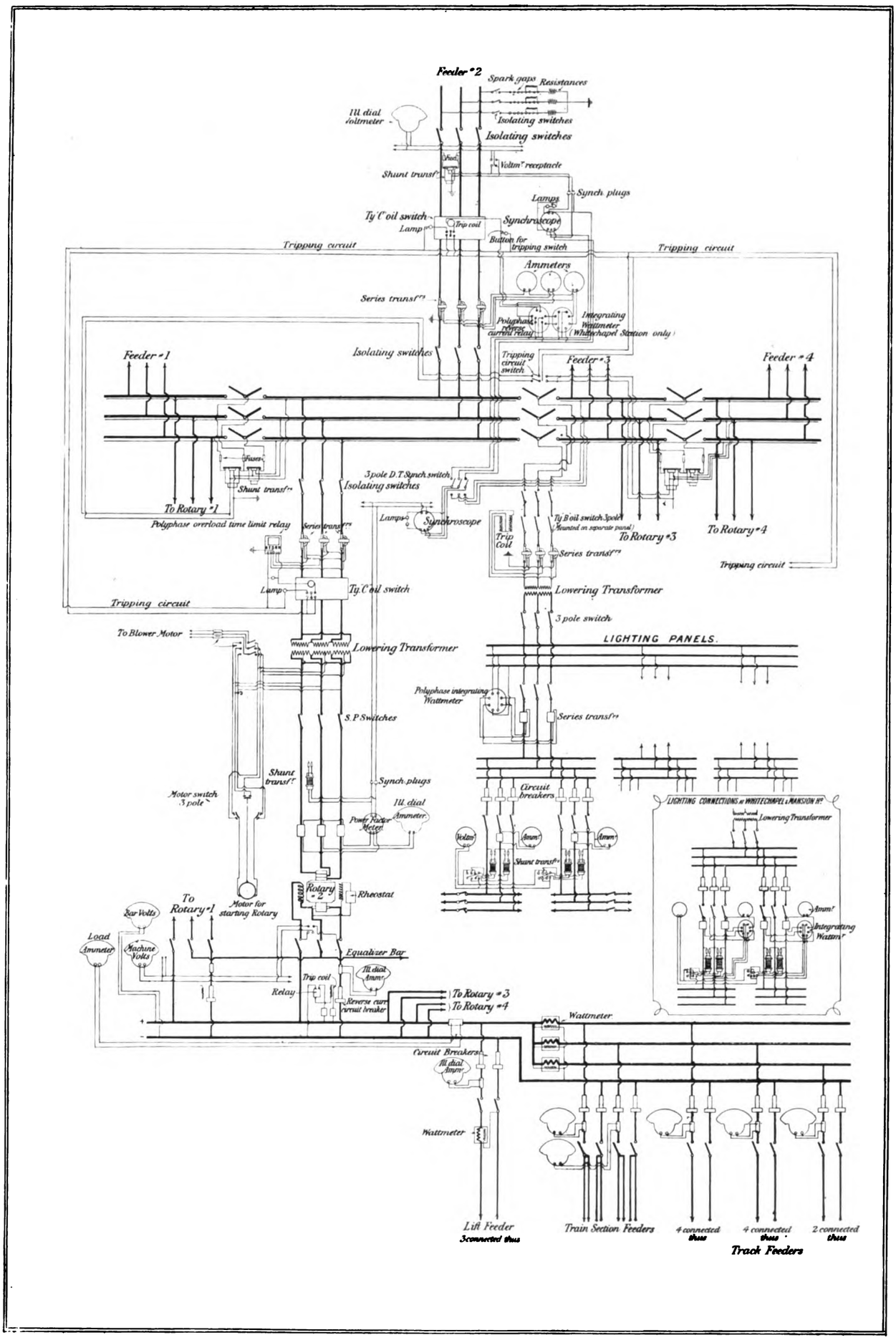

Fig. 45.- Diagram of Connections at Charing Cross Sub-Station.

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any chance be fed from a different set of busbars at the generating station.

Main H.T. Busbars.—The main high-tension busbars are divided into four sections, with one feeder and one rotary converter connected to each. These different busbar sections are connected, so that the feeders may be operated independently or in multiple, as the case may require, by means of selector switches similar in construction to the isolating switches, and operated by a pole and hook. As isolating switches are also fitted in each rotary-converter circuit, it will be seen that the arrangement is very flexible, it being possible to shut down any feeder or any rotary for inspection or repairs without interfering with the general working of the station. The instrument potential transformers are connected to two sets of busbar selector switches, thus ensuring continuity in the supply of current to the instruments when any of the feeders are shut down. Connected to the middle set of busbar selector switches are the transformers for the alternating-current lighting circuits; and by this arrangement it is possible to throw the lighting load on to either pair of in-coming feeders.

Rotary Converters.—The leads from the feeder busbars to the converters are connected first to a set of isolating switches and then through the main oil switches to the primaries of the step-down transformers. The secondaries of the latter are connected through three single-pole knife switches to the collecter rings on the rotary. The main high-tension triple-pole oil switch for controlling each rotary is hand operated in the ordinary course of work, but it is also equipped with a polyphase overload time-limit relay which automatically trips the switch in the event of a prolonged short-circuit or overload; a push button on the switch panel is also provided for tripping this switch electrically. For the direct-current side of the rotary two knife switches are provided, one for each pole, a reverse-current circuit-breaker being inserted in the negative main. The equaliser switch is not mounted on the switchboard panels, but on a cast iron pedestal placed close to the rotary converter. The latter is started up by means of a small induction motor, the starting switch for this motor being placed on the corresponding panel of the alternating-current switchboard.

Direct-Current Feeders.—In order conveniently to measure the current supplied by these feeders to the three railway systems controlled by the Underground Electric Railways of London, which are fed from this point, the positive busbar is split into three sections after passing the load panel, and each section is fitted with a direct-current integrating wattmeter. The first wattmeter measures the output of one train section feeder and four track feeders; the second wattmeter the output of one train section feeder and four track feeders; and the third wattmeter the output of two track feeders. Three additional feeders, which supply current for operating the lifts, have each a separate integrating wattmeter.

Lighting Circuits.—The lighting circuits are on the three-phase system, each sub-station supplying lighting current to a point approximately midway between the adjacent sub-stations on either side. Interconnecting switches are placed at these intermediate points in order

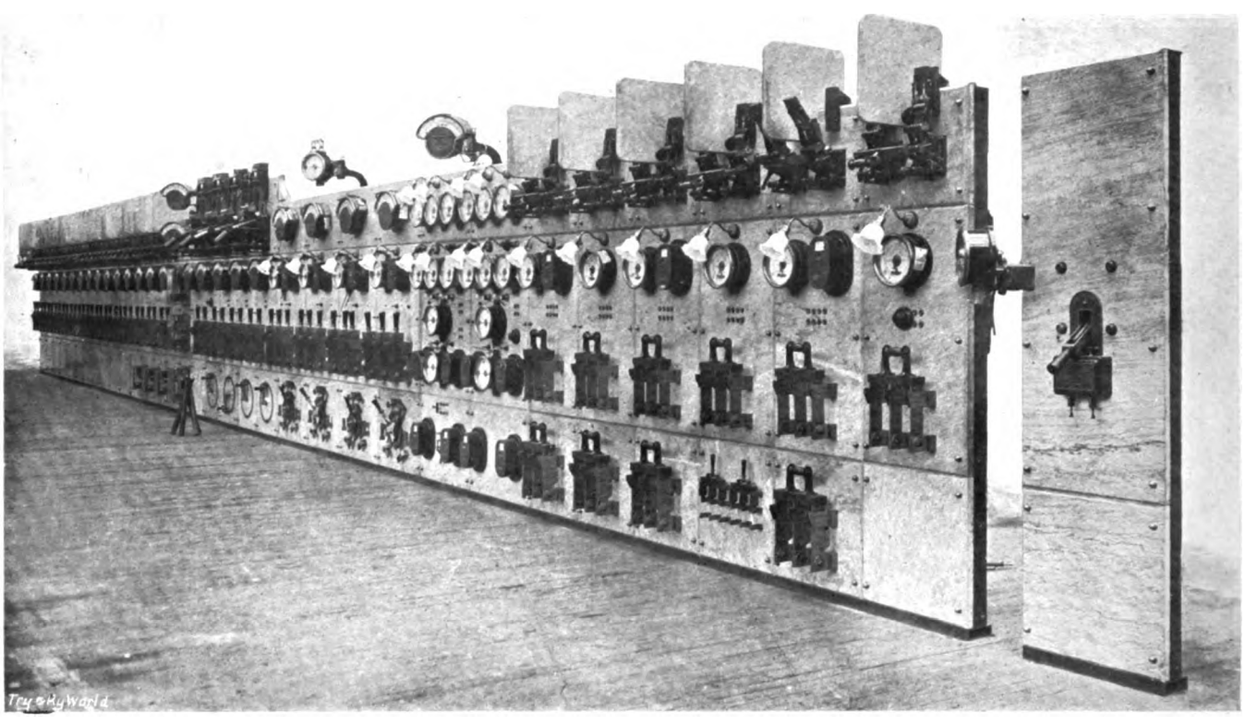

Fig. 47. Charing Cross Switchboard, Right Hand End, Front.

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to maintain a continuous supply of lighting current in the event of one sub-station breaking down or being shut down for any reason. The high-tension switchboard panel controlling the lighting circuits is mounted separately and apart from the main switchboard panels, a type B triple-pole automatic oil switch being used to protect the transformer. The low-tension alternating-current lighting busbars are divided into three sections in order to facilitate interconnection; the transformer feeds direct through a triple-pole switch to a set of busbars, from which are taken three tappings to three separate and distinct sets of busbars, each of which has two outgoing lighting circuits connected to it. There are consequently six lighting circuits in all. These three distinct sets of busbars supply current to the District Railway, the Baker Street and Waterloo Railway, and the Charing Cross, Euston, and Hampstead Railway, each of which has two of the six circuits allotted to it. Integrating wattmeters are placed in each circuit, by means of which the lighting current supplied to the various railways is kept distinct, and their respective amounts measured.

Switchboard Panels.—The switchboard panels are built of blue Vermont marble, polished on the front face, and with ½ in. bevels all round one edge, the total length of the switchboard being 69 ft. 4 in. Commencing from the right-hand end when facing the board (Fig. 47) we have first the alternate-current lighting panels controlling the six circuits just referred to. Each pair of circuit panels has mounted on it double-pole circuit breakers, two ammeters, one integrating wattmeter, two 800-ampere triple-pole knife switches, and one triple-pole 1,000-ampere switch connecting the sub-lighting busbars with the main busbars. In addition to the apparatus above mentioned there are two triple-pole two-way 100-ampere switches for controlling the blower motors which supply air for cooling the transformers; and also one main triple-pole knife switch, which entirely isolates the lighting transformer on the low-tension side.

Mounted on a swinging arm at the side of these panels is a 300-volt instrument, together with the necessary sockets and connections, required for measuring the voltage of any phase and of any low-tension feeder by inserting a plug.

Adjacent to the sixth lighting panel are two instrument panels, each of which is connected to two of the four in-coming high-tension feeders. The instruments on each of these panels comprise six 300-ampere ammeters; two synchroscopes for testing the phase before the feeders are put into service; two integrating wattmeters, and two polyphase reverse-current relays. These instrument panels may be seen in Fig. 47, and it will be observed that all the instruments are adequately illuminated by four incandescent lamps placed on brackets. Below the ammeters and in full view of the attendant are placed two red globe signal lamps, which are connected with the two main feeder switches in such a manner that should either of the latter open automatically through a fault, the respective signal lamp will immediately light up and so warn the attendant. On this panel are also mounted two voltmeter switches, one for each feeder, and the two push buttons for tripping the main switches. Mounted on the top of

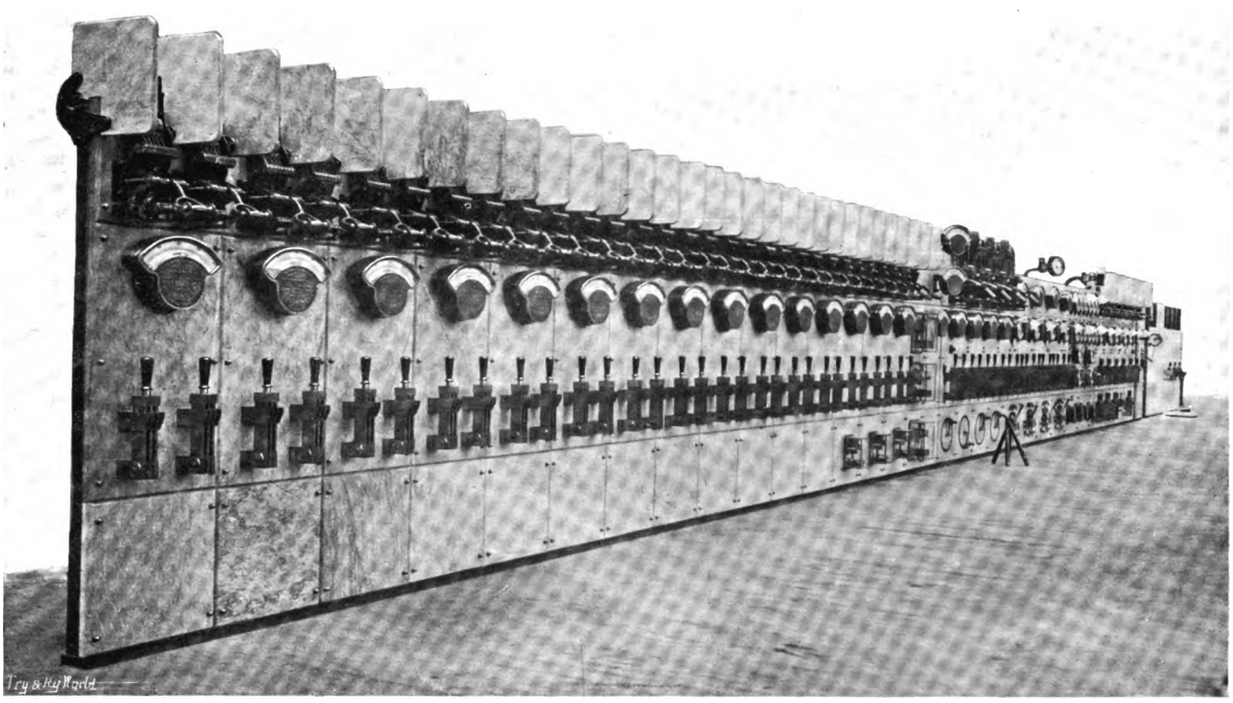

Fig. 48.—Charing Cross Switchboard, Left Hand End, Front.

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the two panels is a large illuminated dial voltmeter, this being fitted on a short double-jointed bracket, which enables the instrument to be turned in any convenient position.

Next to the two feeder panels are four alternating-current low-tension panels for the rotaries, two of which panels may be seen in Fig. 49. Each of these carries one large open-scale illuminated dial ammeter, one power-factor meter, and one polyphase overload time-limit relay. Close to each power-factor meter is placed a red globe signal lamp similar to those on the high-tension feeder panels, and used for the same purpose in connection with the oil switches connecting the rotary converter transformers with the busbars. Below these instruments, and in a convenient operating position, are three large single-pole knife switches which control the low-tension alternating-current side of the rotary. On the sub-base of each alternating-current panel is the rotary starting switch, controlling the starting motor for the converter. Mounted above these four panels, and in a middle position, is a synchroscope which, like the large voltmeter mentioned above, is mounted on a double-jointed bracket, which enables it to be turned in either direction when the rotaries are to be paralleled. This instrument can be seen in Fig. 47.

Following the alternating-current rotary converter panels are the four direct-current panels for the same machines, a good view of which is given in Figs. 49 and 50. Mounted on each of these are one 4,000-ampere circuit-breaker with a reverse current relay attachment, one large open-scale illuminated-dial ammeter, one voltmeter plug switch, and two 4,000-ampere single-pole knife switches. On the sub-base of these panels is placed the rheostat dial switch.

After the direct-current rotary panels are placed the main load panel, on which are mounted two large open-scale illuminated-dial voltmeters, one of which is the busbar and the other the machine voltmeter. A large illuminated-dial ammeter, measuring the total busbar current, is also fitted on this panel.

Next to the load panel is the wattmeter panel, which is fitted with three wattmeters having capacities of 8,000 amperes, 6,000 amperes, and 4,000 amperes, respectively. These three

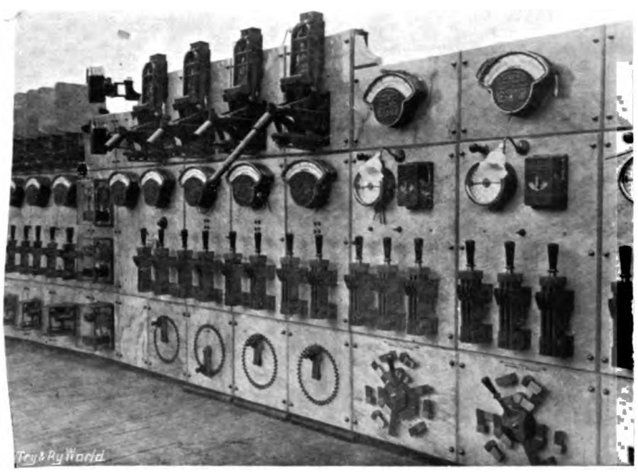

Fig. 49.—Charing Cross Switchboard, Centre Front.

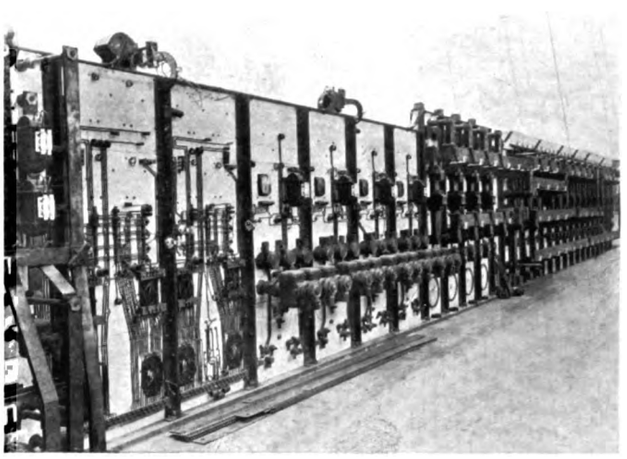

Fig. 50.—Charing Cross Switchboard, Centre Back.

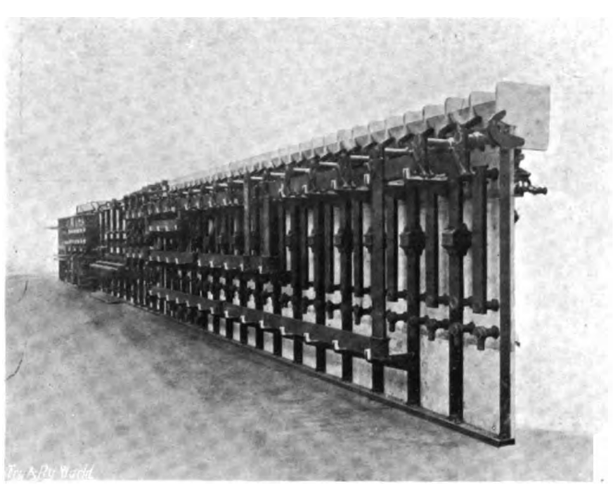

Fig. 51.—Charing Cross Switchboard, Left Hand End, Back.

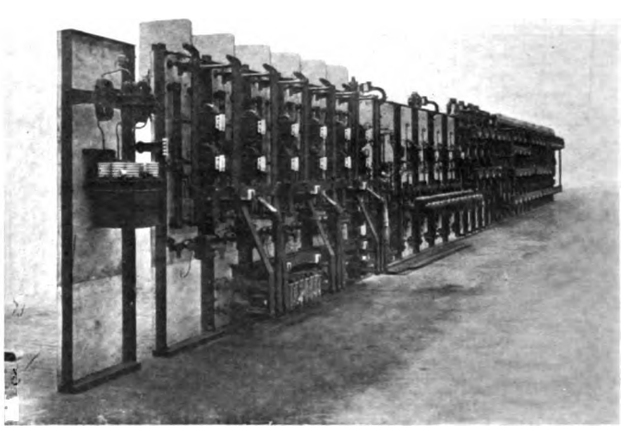

Fig. 52.—Charing Cross Switchboard, Right Hand End, Back.

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instruments separately measure the power supplied to the three supply busbar sections previously referred to, and are for the District, Baker Street, and Charing Cross and Hampstead Railways respectively. After the wattmeter panels are placed three lift panels, which control the supply of current to the lifts. Each of these panels is fitted with its own wattmeter, so that the amount of power used for this purpose is registered separately from that supplied to the track.

Adjoining the lift panels are placed twelve train section and track feeder panels, each of which has a capacity of 3,000 amperes. The wattmeter connections from these twelve panels are so arranged to enable the output to be measured

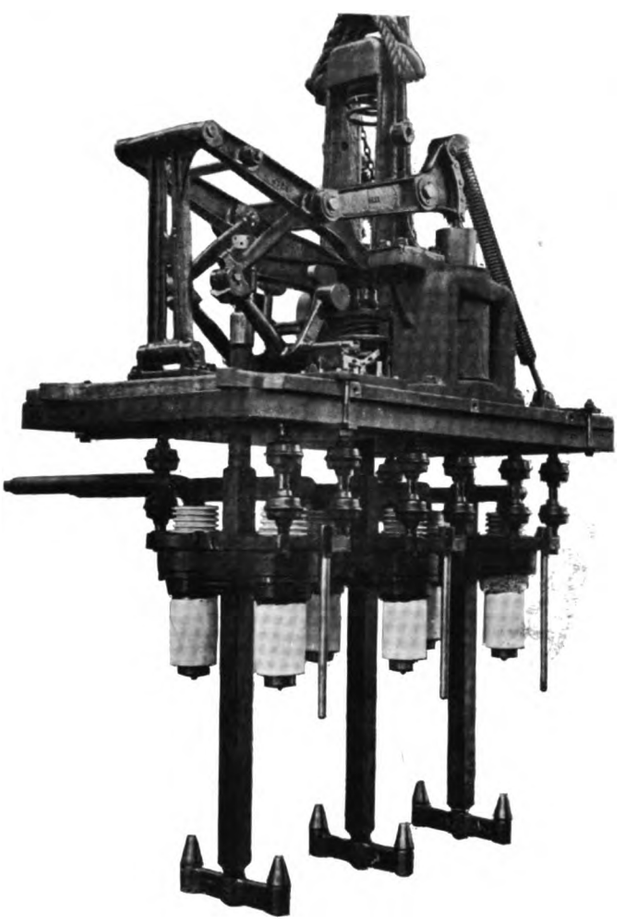

Fig. 53.—Type C Oil Switch (off position) in Sub-Stations.

in two groups of five panels each, for the District and Baker Street and Waterloo Railways respectively, and in one group of two panels for the Charing Cross, Euston, and Hampstead Railway. Figs. 48 and 51 give the best views of these. All track feeder panels are individually fitted as follows: Two single-pole 3,000-ampere circuit breakers; one 4,000-ampere illuminated-dial ammeter; and two 3,000-ampere single-pole knife-switches. It will thus be noticed that these feeders are double-pole, and that they have a circuit breaker on each pole. This double-pole arrangement is necessary owing to the fact that both the positive and negative rails are insulated throughout.

The busbars are built up of flat copper straps 6 in. wide by ¼ in. thick, and ventilating space is left between each strap, to enable the temperature rise in the bars to be kept at a minimum. Fig. 51 gives a good view of the busbars.

In order to make a neat and mechanical job of the voltmeter and other small wiring, ⅜ in. fibre distance-pieces are placed between each marble slab and the angle-iron supporting it. Fig. 50 shows the appearance of the small wiring at the back of the instrument panels depicted in Fig. 47.

The low-tension series transformers for operating the low-tension alternating-current ammeters are of unique design in that they consist only of a secondary winding and magnetic circuit. It is only necessary to slip these over the switch studs, the latter forming the primary of the transformers, so making a neat and compact arrangement.

High-tension Gear.—The high-tension gear has been designed to minimise the fire and life risk as far as is possible. The whole of the high-tension cables, series transformers, etc., are mounted on a fireproof brick screen called the high-tension wall, a series of small vertical brick cubicles or slots being formed in this wall. The cables are run in these slots, so that any fire starting in a cubicle is entirely confined thereto, and is not transmitted to adjacent ones. The high-tension busbars are arranged in similar brick slots or cubicles, but in this case they are horizontal instead of vertical. The spark-gaps or lightning arresters are installed in a fireproof chamber fitted with fireproof doors which can readily be opened for inspection purposes. These chambers are very similar in construction to those for the main oil-break switches, and are placed alongside them.

High-tension Oil-break Switches. — The oil switches installed for the high-tension feeders and rotaries are operated by means of hand levers similar in construction and arrangement to those used for the operation of railway signals. These switches are automatically tripped by relays actuated from the instrument potential circuit. The essential features of the oil-switch are: The entire immersion of all live parts in oil, the positive and direct action, the maintenance of the open position by gravity, and the small quantity of oil necessary. The oil tanks can be easily removed without dismantling the switch or circuit breaker as it is sometimes called.

These switches are erected in a masonry structure, each of their three poles and the oil tank in which they are immersed being in a separate fireproof compartment. There are two stationary contacts per pole, one connected to the incoming lead and the other to the outgoing lead of the same phase, each contact being mounted within a large porcelain insulator. These insulators are mounted on a cast iron frame which forms the top, and supports the

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enclosing oil tank. The frames are fastened by means of strain insulators to the under side of a stone slab, placed on the top of the cell structure and under the cast-iron base of the operating mechanism.

Fig. 53 shows a Westinghouse oil switch apart from its brick seating. The movable contact for each pole consists of a U-shaped copper piece fastened to the end of a stout wooden rod. In the closed position of the switch this U-shaped piece electrically connects the two stationary contacts of each pole. The wooden rods are fastened at their upper ends to a common cross bar, which, through a system of levers giving a straight line of motion, is raised by means of the closing magnets, assisted at the beginning of its motion by a pair of balancing springs. A toggle joint automatically locks this system of levers when the circuit breaker is in a closed position. When the switch is put "off" the toggle is released by a blow from a tripping magnet, which with gravity, assisted by a powerful spring, causes the cross bar with the movable rods and contacts to drop to the open position. There are two breaks in series for each pole or phase of the switch, each break consisting of a fixed and movable contact. The movable contact consists of two cone-shaped projections which fit into corresponding projections and recesses on the fixed contact, the projections on the movable contact being so arranged that the middle or inner cone engages the fixed contact before the outer cone. When the switch is opened the outer contact disengages first, so that the break is small in the inner projection; in this way all arcing that may occur is taken by this centre contact, and as this is removable, it can be replaced when worn out.

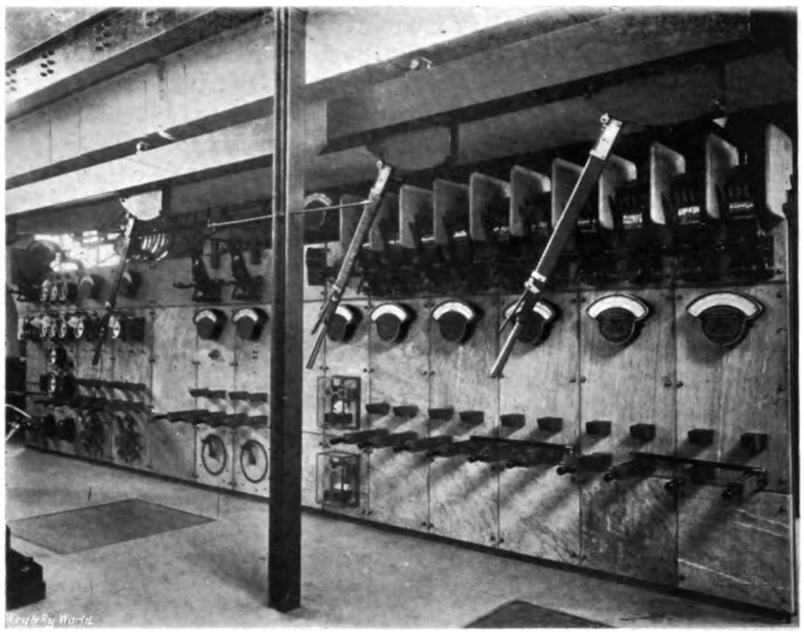

Fig. 54.—Putney Bridge Switchboard, Right Hand End, Front.

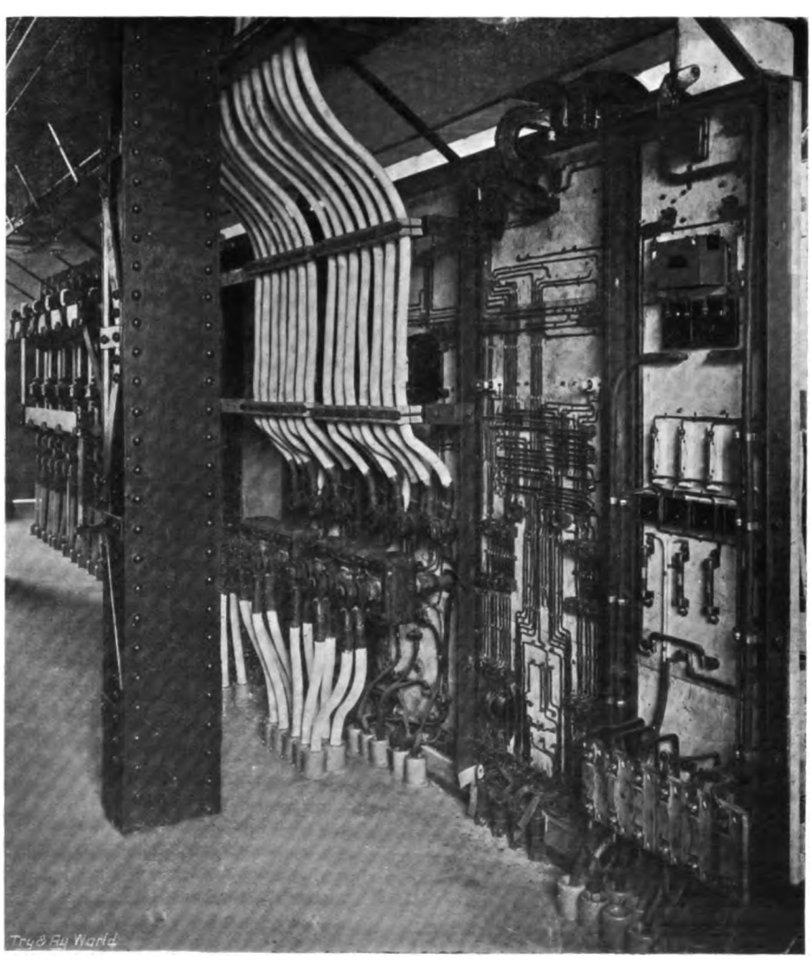

Fig. 55.—Putney Bridge Switchboard, Left Hand End, Back.

The oil tanks are constructed of heavy sheet metal, and are held in place by means of clamps to the under side of the frame carrying the terminals. The interior of the tanks is lined with insulating cement, moulded in such a form to fit closely about the terminals and moving contact pieces, leaving just room enough for free movement of the parts in the oil. By this means the amount of oil and fire risk is reduced to a minimum, the wooden rod interposing an effective barrier between the two terminals of each pole when the circuit-breaker is open. Suitable levers are provided for handling the tanks; and they can be readily lowered away from the contacts and removed without dismantling the switch mechanism.

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The construction is such that the entire circuit-breaker may be set in place and lined up with the contacts exposed to view to enable them to be accurately adjusted before the oil tanks are placed in position. All sediment formed in the oil settles at the bottom of the tank, leaving the oil clear about the contacts; the oil level is readily determined by means of a small sight gauge. When necessary, arrangements can be made for a tank to be

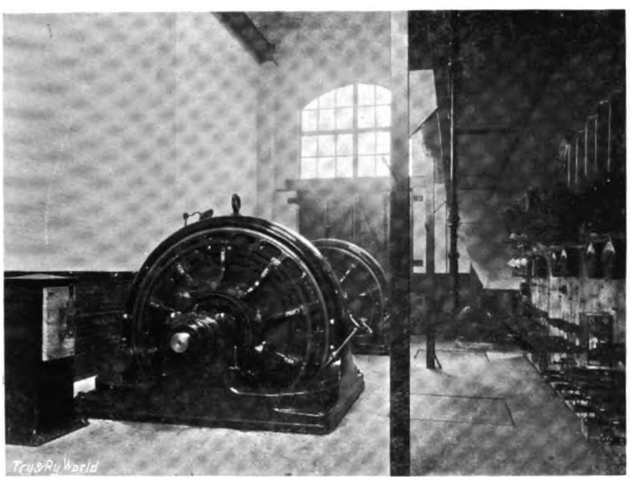

Fig. 56.—Rotary Converters in Putney Bridge Sub-Station.

drained or re-filled without moving it from the circuit, and as all the live metal parts are immersed in oil, there are absolutely no live high-tension parts exposed.

Mounted on each circuit-breaker is a small double-pole, two-way knife switch, which is connected in the red-lamp indicating circuit, and is operated by the motion of the levers of the circuit-breaker. Thus the position of this small switch depends on the on or off position of the large switch. A polyphase overload and reverse-current relay, for the rotary and feeder switches respectively, is connected to the series transformers in the main circuit, and provides for the automatic operation of the high-tension oil break switches.

Figs. 54 and 55 give front and back views of the main switchboard at the Putney Bridge sub-station of the London Underground Electric Railways. This is smaller than that at the Charing Cross sub-station, as the density of the traffic is much less, but it is arranged in the same general manner, and may be compared with the Charing Cross board. The arrangement may be taken as typical of that for most of the other sub-stations which feed only one railway. Internal views of the building are shown in Figs. 56 and 57.

All the electrical work connected with the erection of the sub-stations and the installation of the plant therein has been under the supervision of Mr. S. B. Fortenbaugh, for the Underground Electric Railways Company.

PERMANENT WAY EQUIPMENT.

The great work represented by the electrical equipment of the permanent way and the laying and connecting of the low-tension feeders from the sub-stations to the conductor rails has been carried out by the Underground Electric Railways Company, with Mr. W. E. Hanson in charge. The job was commenced in July, 1902, and was practically complete at the end of the past year. The earlier part of the work consisted of the electrical equipment of the line from Mill Hill Park to South Harrow, experimental running on which with power from a small temporary generating station began, as previously mentioned, in June, 1903. The total length of route which has been electrically equipped is 41 miles, all double track, with sidings and cross-overs. Out of this, the District Railway itself accounts for 29¼ miles, while of the remaining 11¾ miles, 7 miles represents the Richmond and Wimbledon routes of the London and South Western Railway, and 4¾ miles the Whitechapel and Bow Railway and the electrified portion of the London, Tilbury, and Southend Railway. Opportunity was taken to renew the track rails and sleepers, where necessary, while the other work was going on. Though the ordinary sleeper is fairly incombustible when buried in ballast, double security has been sought by providing that all the new sleepers are of Jarrah wood. On the central parts of the railway work could only be carried on between the hours of one and five in the morning, and on most of the other parts of the line very little could be done in the day time. It was altogether a nocturnal job,

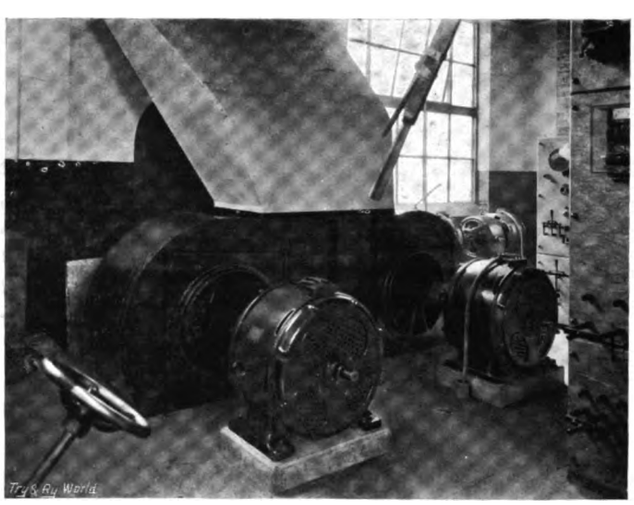

Fig. 57.—Blowers for Transformers, Putney Bridge Sub-Station.

and presented many difficulties. As many as 1,000 men were sometimes employed upon it. The widening of the District line where the Great Northern and Brompton Railway comes to the surface at Kensington is still in progress, and upon this a very large number of men are employed.

Conductor Rails.—The position of the conductor rails, relatively to the track, is similar to

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that on the Metropolitan Railway, this being absolutely necessary owing to trains of both companies running round the Inner Circle. Instead of the track rails being used as the return for the current, a fourth rail is provided, so that the whole working current is insulated from earth. The third rail or positive conductor is carried outside each track, being on the left-hand side looking in the direction in which a train proceeds, while the fourth rail or negative conductor is placed centrally between the track rails. A cross section of single track is given in Fig. 58, showing the relative position and elevation of the rails, while Fig. 59 is a section of the conductor rail on a larger scale. It will be seen that it is a substantial T section, and it weighs 100 lb. per yard. The feature of these power rails is their softness and high conductivity. The steel of which they are made contains only ·07 per cent. of carbon, and the electrical resistance was specified to be only from 6½ to 7 times that of pure copper. The resistance of an ordinary steel rail is about 12 times that of copper. At first there was some difficulty in getting rails of the required softness and composition from British makers, and a considerable quantity was obtained from Germany. Later, however, a contract was entered into with Messrs. Bolckow, Vaughan, and Company, under which that firm have supplied about two-thirds of the total quantity required. The electrical resistance of the rails latterly supplied has been under 6½ times that of pure copper. For double track four conductor rails are of course required, so that the quantity works out at 314 tons to the mile, making 12,874 tons for the 41 miles equipped. At junctions numerous breaks in the conductors are necessary, and where the gaps occur the rails end in tapering nose-pieces, similar to those used on other electrified steam railways in the country. The slope of the end of the upper surface of the rail enables the shoe on the car to take the contact without shock.

A view of the complicated work at the junction to the west of Earl's Court station is shown in Fig. 60.

The conductor rails are mounted on insulators of Messrs. Doultons' make, the appearance of which is shown in Figs. 61 and 62. The higher pattern is for the positive rail, so that it may be raised to the required height. The low pattern is for the negative rail. The insulator, which is bolted down to the sleeper, consists of a block of cream-enamelled vitrified stoneware, with base

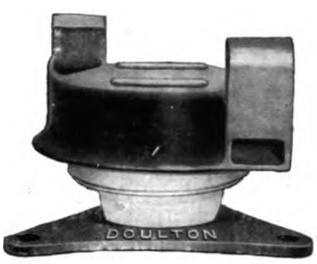

Fig. 62.—Conductor Rail Insulator, Low Pattern.

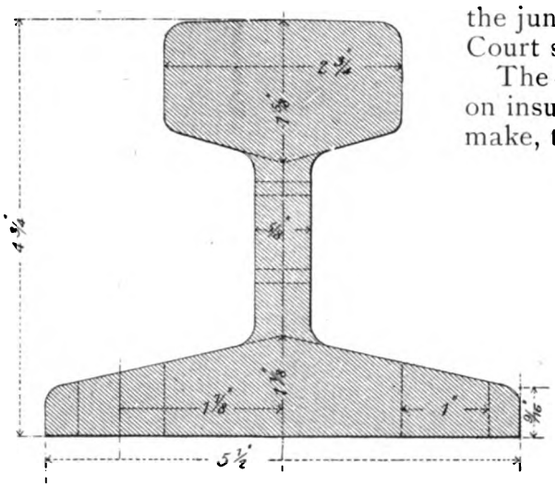

Fig. 59.—Section of Conductor Rail.

Fig. 61.—Conductor Rail Insulator, High Pattern.

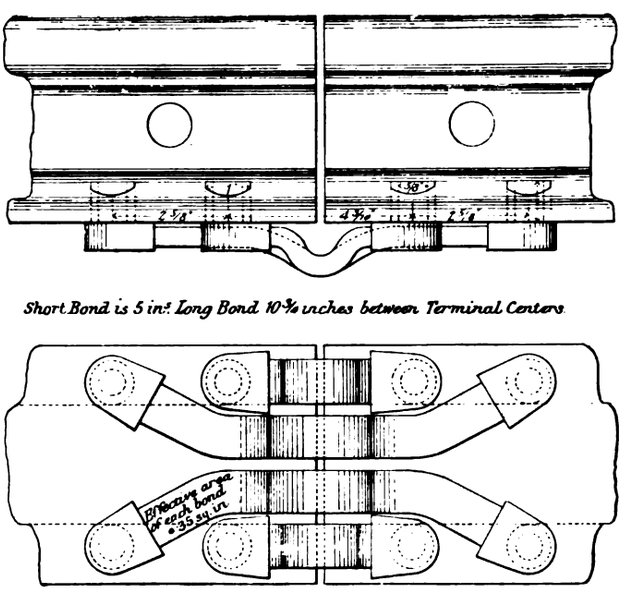

Fig. 63.—Elevation and Plan of Rail Bonds.

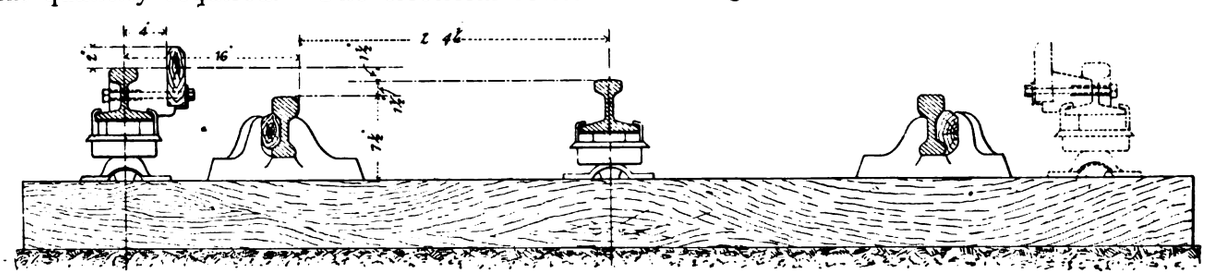

Fig. 58.—Cross Section of Single Track, Showing Conductor and Track Rails.

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and cap of malleable cast-iron. The cap is made with lugs to hold the base of the conductor rail.

The positive conductor rail is protected at the tunnel stations by wooden planking on edge, and this protection is also provided over the whole length of the railway which is not in tunnel. Doubtless this is more necessary than on the electric railways in the north of England, as these in their interurban portions pass through relatively sparsely-populated districts. At signal cabins and at other places where men have to cross the line the positive conductor is protected by two planks, one on each side, so that it is hardly possible, except by set purpose, for a person to make contact with the rail. Where the single board is used, it is placed on the inside of the conductor rail, so as to prevent any tool falling from bridging the conductor and adjoining track rail. A filling block is placed between the conductor and the plank, and a bolt through the web of the conductor, the block, and the plank holds all securely together. The bolt hole in the conductor is provided with a fibre bushing which insulates the bolt from the conductor. The upper edge of the board is 2 in. above the level of the head of the conductor rail, and the horizontal space between the centre of the head and the plank is 4 in.

Bonding.—The type of bonds employed, which were made by the American Steel and Wire Company, is shown in Fig. 63. There are four bonds, two long and two short ones, for each joint, and they are all under the base of the rail. They are flexible stranded copper wire bonds, and the two sizes are 9 in. and $4\frac{1}{2}$ in. long respectively. The terminals are of solid copper, and were expanded by drift pins driven in after the bonds were in place. The rails were drilled for the bonds before being laid down, but just before inserting the bonds the holes were enlarged $\frac{1}{16}$ in. so as to make them clean.

Feeder Arrangements.—The conductor rails are divided into insulated sections, the length of which varies according to the amount of railway traffic to be dealt with, the sections on the busy parts of the line being comparatively short. There is one feeding point for each section. Opposite every sub-station there is a short section about 350 ft. long called a train section, being a little longer than the length of a train, and this is fed independently and insulated from the rest of the conductor rails. By means of this arrangement, if anything goes wrong with a main section in the way of a short-circuit, when a train passes over, the circuit-breaker of only one main section is blown instead of the circuit-breakers of two main sections.

For every section, long and short, there are four low-tension feeders from the sub-station supplying that particular part of the line, two positive feeders and two negative, one being connected with each of the four conductor rails

Fig. 60.—Junctions and Crossings at Earl's Court, Showing Track and Conductor Rails.

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of the double track. The feeders are copper wire cables, rubber-insulated and lead-covered, and are carried in conduits alongside the track to the feeder terminals. The feeders for the train sections each contain 61 wires of No. 12 gauge, and are ¾ in. in diameter, while the cables for the main sections are of 169/12's, and 1½ in. in diameter over all. The terminal at the feeding point is of some interest. A Jarrah timber post about 4 ft. high and 6 in. square is sunk for the greater part of its length in the ground. The upper end is a blunt cone, and a circular passage rather wider than the feeder cable is bored from the top down the interior of the post for about two-thirds of its length, and then is brought out at one side. The cable is led in by the side opening, and up the interior of the post to the top. A copper cap, with an internal socket of the diameter of the cable, is secured over the top of the post, and the end of the cable is sweated into the socket. A T-shaped heavy copper bracket is screwed at its shank end to the top of the cap in a horizontal position, and on the underside of the cross of the T are three recesses or sockets. Three short connecting copper cables, each of 61/12's, are sweated into these sockets, while their other ends are similarly secured in sockets in the side of a copper bar which is bolted to the web of the conductor rail. The rail is drilled and tapped with four threaded holes 1 in. in diameter, and the bar, which is 1 ft. long and 1¾ in. deep, is firmly connected with the rail by gunmetal bolts and lock-nuts. The web of the rail is cleaned before the bar is screwed up. This arrangement, which is both flexible and efficient, was designed by the engineers of the Underground Railways Company. The scheme for the return feeders connected with the negative conductor is similar to that just described. The total length of low-tension feeder cables required amounts to over 22 miles, and they were supplied by the British Insulated and Helsby Cables, W. T. Glover and Company, and the Electrical Company. The above length includes the short pieces of cables required for bridging gaps in the conductor rails at points and crossings.

AUTOMATIC SIGNALLING SYSTEM.

The system of automatic and semi-automatic signalling which has been installed on the railway is in part similar to electro-pneumatic signalling systems in use on several railways in this country and abroad, and the automatic part of the system bears some resemblance to that used on the New York Subway and the Boston Elevated Railway, but there are differences in regard to many matters, and the system as installed on the District Railway is believed to be the finest and most complete in the world. The conditions on the railway are so different from any obtaining elsewhere, that the apparatus had practically to be specially designed for the work.

The Mechanism.—All automatic and semi-automatic signals are controlled by track circuits. In every sub-station on the railway are to be found a small motor-generator (driven by low-tension alternating-current from the transformers) for furnishing a low-pressure continuous-current for the track circuit, and an electrically-driven air compressor for providing compressed air to work the pneumatic motors which operate the signals and points. The potential of the low-pressure current is 60 volts, and the air pressure used is 70 lb. to the square inch.

All the air compressors in the sub-stations pump air into one main, which runs the whole length of the railway, so that in the event of any compressor being shut down the rest are available for the work. The pneumatic motors are similar to those used in the Westinghouse electro-pneumatic system of working signals and points in use on other railways.

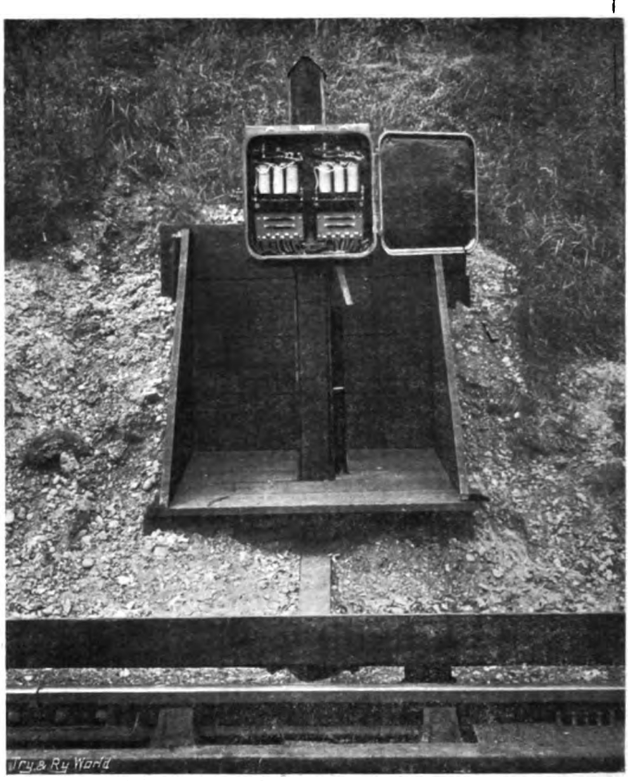

Fig. 64.—Automatic Signalling Relay.

The track rails of the line are lightly bonded. One of these rails is electrically continuous over the whole extent of the railway, and constitutes the positive conductor from the motor-generators, while the other rail is divided into insulated sections by means of special rail joints insulated with fibre. Connected electrically between the two rails are electric relays, two for each section, one being at each end of the section. One of these relays is shown in Fig. 64. A return electric main runs the whole length of the railway, and the sectioned rail is connected with it through resistances at that end of each section at which the train leaves.

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It should be noted that as the motor generators in the sub-stations have a low internal resistance, it is necessary to instal the resistances before-mentioned between the track and the negative signal main, so as to prevent the short-circuiting of the track circuit by a train short-circuiting the generator at the sub-station. In fact, the

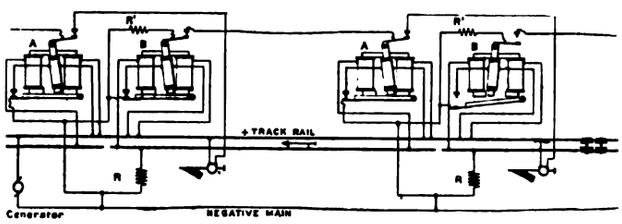

Fig. 65.—Diagram of Automatic Signal Connections.

short-circuiting of the track must not to any great extent increase the current in that particular circuit from the main, as it is necessary that the main which feeds other track circuits should remain at a fairly constant potential. This would not be the case if the current variation by the short-circuiting of individual track circuits was great.

A diagram of the connections is given in Fig. 65. The track coils of the relays are permanently connected across the rails. Between the pole pieces a polarised armature, bearing a winding of considerable resistance, is suspended from a pivot. This armature is connected between the positive rail and the negative main through a contact—operated by the track coil armature—which is closed when the track coils are energised. To the polarised armature is rigidly connected an arm which actuates a contact, the function of which is to open or close the local circuit controlling the signal motors. It will thus be seen that when there is no train on the section the relay track coils are excited and draw up their armature, which closes the circuit through the polarised armature. The latter is then attracted to one of the poles of the relay, and so closes the contact in the local signal circuit. The two relays in each section are duplicates, and the contacts in the local signal circuit are in series. Unless both these contacts are closed no current can flow through the signal magnet, and the signal will therefore remain at danger by gravity.

When a section is unoccupied by a train, current passes from the continuous rail by way of the sleepers and ballast and through the relays, all in parallel, to the sectioned rail, and thence to the negative main through the resistance previously mentioned. This resistance is adjusted in relation to the combined resistance of the relays and ballast (in multiple), so that there is a potential drop between the rails of from two to five volts, the remaining drop from 55 to 58 volts being across the resistance itself. When a train comes on the section, the two rails are short-circuited through the car wheels and axles, the resistance of which is negligible, and the relays are thus de-energised. This opens the circuit through the signal valve magnet in the motor, which is thereby de-energised, resulting in the closing of the connection between the motor cylinder and the air main, and the opening of a port from the signal cylinder to the atmosphere. Thus the air pressure is taken from the motor piston and the signal goes to danger by gravity.

The track circuits are carried through the interlockings, and here it is evident that many cases arise where several signals, all giving access to the track-circuited section, are controlled by the same. The actual signal that is lowered depends, of course, on the position of the points.

All signals outside interlocking limits are entirely automatic. At interlockings the signals are semi-automatic, that is to say, the signalman cannot pull such a signal off to clear unless the track-circuited section to which it gives access is unoccupied by any vehicle. If after the signal has been pulled off by the signalman a vehicle enters the section from either end, the signal is automatically thrown to danger, and remains in this position, even after the section is unoccupied, until the signalman replaces his signal lever to its normal position and again pulls it over. The signalman can place a signal to danger at any time by putting his signal lever back. A semi-automatic signal may thus be said to be "slotted" by the track circuit.

Both signals and points at junctions and cross-over roads are worked electro-pneumatically

Fig. 66.—Interlocking Signalling Frame, Mill Hill Park.

from a locking frame, such frames being of the Westinghouse Brake Company's standard type as installed on other railways. A view of the frame in Mill Hill Park signal cabin is given in Fig. 66.

There is no point on the District Railway where a train is not automatically protected, as the whole of the company's lines is track-circuited. Every train, as soon as it gets on the main line, is under the protection of the track

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circuit through interlockings and between interlockings. Moreover, in the majority of cases the yards as well as the sidings are track-circuited. While a train is in a siding, under certain conditions, the train holds the siding or shunting signal at danger. Under other circumstances the track in the siding controls no signal, but it gives the signalman in the cabin a visual indication of its condition. The signalman, looking at his indicators, can tell the position of the various trains in the sidings throughout his yard. This is effected by means of a new feature which has never before been used. In place of the ordinary cabin diagram showing the lay-out of the yard and the situation of points, signals, and so forth, an illuminated diagram is installed in the signal-box on which the position of every train in the near neighbourhood is shown. This diagram consists of the ordinary drawing of the lay-out of the yard, the signal positions, etc., but in addition the four-foot way on the diagram is illuminated from behind by electric lamps. These lamps are controlled by the track-circuit indicators in such a way that when a train enters a given track circuit the lamps behind the diagram which illuminate the section of the line on the diagram corresponding to the section occupied by the train are extinguished, thus showing that the track circuit is occupied by the train in question. When the train passes into the next track circuit the previous track circuit is reilluminated, while the lamps behind the representation of the latter one go out.

Protection from Extraneous Currents.—The track system of signalling (which may employ alternating or, as in the present case, direct current) has worked with great success on steam railways, but its application to electrically-operated lines had, originally, an extremely serious drawback. The traction current extraneous to the signal system would illegitimately operate the track relays and cause false indications of safety. This difficulty was overcome by the Union Switch and Signal Company (who represent Westinghouse signalling in the United States), and the track-circuit system on the Boston Elevated Railway was installed by them. This was the first application of the track circuit on an electric railway, and was an entire success.

The Westinghouse Brake Company of London have supplied the apparatus for the District Railway, and this apparatus, which is an advance on anything hitherto used, is covered by a patent of Mr. H. G. Brown's, of the same company. While the Brake Company supply the apparatus the actual work of installation has been carried out by the Underground Electric Railways Company, with Mr. C. E. Strange in charge as engineer for the signalling system.

To return to the trouble from extraneous currents, in track-circuiting the operation of the signals depends upon the energisation and de-energisation of the track relays. It is plain that these relays may be, so to speak, illegitimately energised by outside current—in the case of the District Railway, from the conductor rails which convey the power for propelling the trains. If this took place, the signal system would be worthless on account of the unreliability of the signals displayed. The relays must be energised to clear the signals only by a legitimate signal current, and under no condition by extraneous current. To effect this, the track circuit apparatus on the District Railway is selective, operating to clear the signal only when energised by the legitimate signal current, and being inoperative and not clearing the signal when influenced by extraneous current. The relays are polarised, so that they answer only to a current in the normal direction, and are connected to the track rails and to each other in such a manner that they can simultaneously receive only a normal current from the legitimate source of signal current supply. Any extraneous current in the track rails, by reason of the interconnection arrangement, energises either one or both of the relays for each section in the reverse direction, and then only when the current has a higher potential than the normal signal current. In this way the relays provide against any accidental contact between the power rails and the track rails which would cause the signals to be operated.

Other Safeguards.—A few other points in the region of safeguards may be noted. If a track rail gets broken, the effect is to throw the signal of that section to danger. Then, the whole apparatus has been designed so that there will be no interruption should the line be flooded, as sometimes has happened in the tunnel sections. The efficacy of this arrangement has already been demonstrated on the Ealing and South Harrow line, which besides being worked

Fig. 67. Automatic Train Stop.

electrically, has also been using the signalling system for a considerable time. On this branch, track circuits 2,100 feet long have operated when the running rails were entirely covered with water, the surface of the water being half an inch above the level of the track rails.

The other main precaution is the "train-stop." Each signal is provided with a stop situated alongside the track (Fig. 67). It consists of a short arm which, when the signal is at danger, is

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raised vertically to such a position that it engages with a cock on the passing train, opening it, and applying the brakes. This, of course, only happens should the driver of the train over-run a danger signal. The pneumatic motor arrangement actuates the stop in the same way as it does a signal. The stop is held by the compressed air in the clear position, and it returns to the danger position when the air pressure is relieved. When the signal stands at clear, the stop arm lies horizontally, allowing trains to pass without interference. Each track circuit overlaps the signal under the control of the following section by a distance greater than that required to bring the train to a dead stop if it received, when passing the signal, an emergency application of the brakes. Therefore, a train standing at the extreme rear end of a block section always has a sufficient distance between it and its protecting signal to ensure a following train being brought to a dead stop before collision, even if the latter should attempt to run by the signal at full speed.

In connection with the signalling, as in regard to other matters, every precaution has been taken against risk from fire, especially on the tunnel sections of the railway. On these sections no wood whatever is used in connection with the signals. All the apparatus, including signals, relay cases, train stops, and their foundations are of iron. Iron and earthenware conduits are employed for all wires. The cases enclosing the relays are water-tight and secured with screws to seal the gasket joint of the door and then padlocked. The electro-magnets of the relays are protected by fuses. The red and green glasses of the signals in the tunnels are mounted on a quadrant which is swung up or down, the signal being close to the ground. On the open sections of the railway the ordinary semaphore arm arrangement is used. The great length, weight and complication of the iron rods and wires along the tracks, inseparable from mechanical signalling, are of course, abolished. As to economy, the total energy used in this track signalling averages less than half a kilowatt per mile of double track.

Train Destination Description.—There remains one important improvement which has never before been employed on any railway, and which is now being installed on the District lines. With a close headway it is very important that trains should not be held by interlocking and by junction points waiting for the routes to be set up. A train reaching a point must continue through the interlocking without delay, otherwise the intended close headway would become impossible. It is also necessary that the passengers waiting on the station platforms should be notified of the destination of trains approaching the stations so that they may prepare to get into the trains with as little delay as possible. Indeed, one of the great points in connection with a frequent service of trains is a quick and intelligent loading and unloading of passengers. To effect these ends, a patented system of magazine train describers is now being installed. These consist of apparatus which is operated from signal cabin to signal cabin. For instance, cabin A sends a describing electric impulse to cabin B giving the destination of the train which is passing cabin A. The apparatus is of a magazine type, so that cabin A can describe to cabin B any number of trains according to the capacity of the railway between A and B, before the first of these trains arrives at B. These descriptions are received and stored automatically at cabin B, and can be produced at the signalman's will in the exact sequence in which they were received. Thus the signalman always knows the destination of trains approaching his cabin, and he is accordingly enabled to adjust his points and clear his signals for the train to pass through his interlocking without delay. The descriptions sent from cabin A are also received by the intermediate stations between A and B, and they automatically show on the station platforms by means of an illuminated sign the destinations of the three trains which will next arrive at the station in the sequence in which they will arrive. Each train cancels its own illuminated destination on leaving the platform, number two on the indicator becomes number one, number three becomes two, and a new train destination shows up as number three. This apparatus, like the rest of the installation, is supplied by the Westinghouse Brake Company and erected by the Underground Electric Railways Company under the supervision of Mr. Strange. As will be plain, the whole scheme is of the most elaborate description, and it promises well both for the expeditious and safe working of the proposed frequent train service and for the convenience of the public.

PASSENGER STATIONS.

A great deal of valuable improvement work has been carried out on the passenger stations, especially those in the tunnel sections of the railway, and it is not yet complete. In order to abolish all risk of fire in the stations, the wooden platforms have been swept away and concrete substituted. This work was carried out along with the laying of the ducts under the platforms for carrying the various electric cables. Manholes have been provided in the platforms for access to the cables. Even the concreting of the platforms was a troublesome job, as unless each portion which was being done was kept carefully fenced till the concrete was set, some perverse passenger would be sure to get his feet into it. Of course, much of the work was done in the early hours of the morning, but it was practicable to carry on some of it at other times. The copings used for the edge of the platforms are of a novel description, being of hard, vitrified earthenware of Doulton make, grooved to prevent slipping, and of a light colour, so as to make the edge of the platform more conspicuous.

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Fireproof stairs to the stations are also being provided, and electric light is being substituted for gas. As soon as the last of the steam locomotives has disappeared from the tunnels, steps will be taken to clean and brighten the interior of the stations, so that they will be much more attractive than they have been in the past. In some cases the platforms were scarcely long enough for the new electric trains, and they have in consequence been lengthened by several feet.

MILL HILL PARK REPAIR SHOPS.

These great repair shops, close to Mill Hill Park station, are probably the finest of the kind in the country. They have been described as car sheds, but their purpose is not so much for storing cars at night—cars ready for service will more frequently stand in sidings when not in use, as is the usual custom with steam railways—as for repairing, painting, and so forth. There was a large piece of unoccupied land close to the railway at Mill Hill Park which was acquired for the shops. It is at a somewhat higher level than the railway, and it is now approached by gradients from each end. The tracks on these gradients depart from the usual British practice, as flat-bottomed rails (weighing 60 lb. per yard) are employed, and these are spiked to the sleepers, no chairs being used. The conductor rails only weigh 45 lb. per yard, and are mounted on low flat insulators. Of course the current to be carried by these rails is comparatively small. As will be seen from the plan, Fig. 68, cars can be brought in by one end of the sheds and passed back to the railway from the other end. There is abundant space for sidings outside the shops. As to the building, the brickwork was erected by Messrs. Ford and Walton, Kilburn, while the steel roof was manufactured and erected by Messrs. Mayoh and Haley. There are over 1,000 tons of steel in the roof principals and stanchions, exclusive of a large quantity of miscellaneous work. The roof consists of 49 framed steel principals in each bay, with steel joist purlins supported on latticed stanchions, and covered with galvanised corrugated sheeting and glass. The roof was erected by means of two steam derrick cranes, which travelled on bogeys the whole length of the building as the work proceeded. The order for the steelwork was placed in the end of October, 1903, and the erection of it was completed in July, 1904.

The roof-glazing was carried out by Messrs. Mellowes and Company, and the lantern is particularly light-looking as the sheets of glass are each over 10 ft. long. The ends of the building are closed by Kinnear rolling shutters, made by Messrs. A. L. Gibson and Company. A view of the south end is given in Fig. 69.

The premises are 800 ft. long by 216 ft. wide, giving an area of over 170,000 sq. ft., and they are divided into three main sections, the wood-working shop, the cleaning and main repair shop, and the painting shop. There are in all eleven tracks through the sheds, giving a total covered track length of over a mile and a half. This can accommodate 25 trains of 7 cars each. The whole appearance is clean, bright, and airy. A typical internal view is that given of the wood-working shop in Fig. 70, which, however, was taken before most of the machine tools had been installed. For the purpose of moving the cars about the sheds, overhead conductors take the place of the conductor rail. They are bulb-tees in section, and are supported in pairs a little distance apart (like a very narrow gauge railway) from bars of Karri wood, which in their turn are hung from the roof girders. On this miniature railway a small four-wheeled trolley runs, and from it two flexible cables are connected to the collector shoes of the car which is to be moved. The premises are heated by radiators, the steam for the purpose being raised by a Babcock and Wilcox boiler erected in a small building outside. In the painting shop the radiators are very numerous, so that the drying of newly-painted cars may be expedited.

In the wood-working shop (70 ft. wide by 27 ft. 6 in. high to the wall-plate), which is on the east side of the building, there are two tracks and pits with concrete floors. The various machine tools are driven electrically, as are also the overhead travelling cranes. The conductors for these are ranged along the side walls under the crane

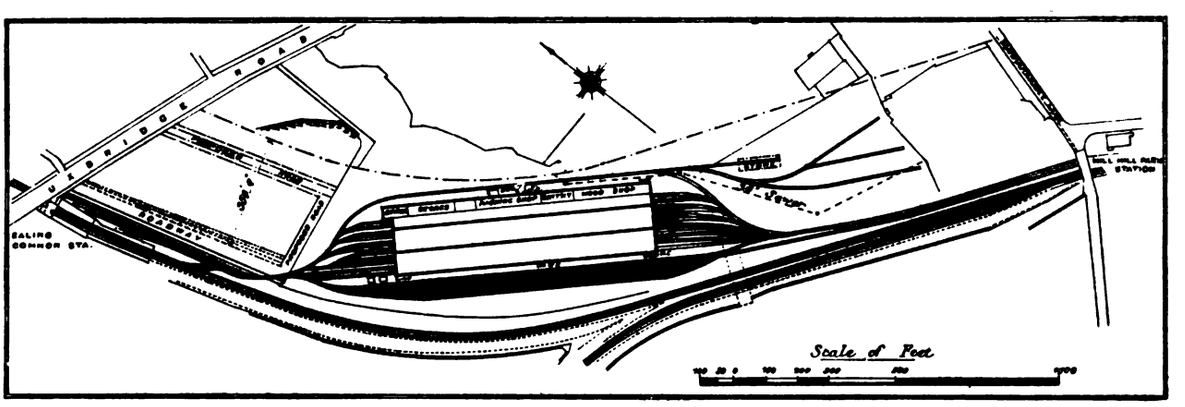

Fig. 68.—Plan of Mill Hill Park Car Sheds Site.

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rails. The workmen's benches are of Karri wood, which is practically incombustible, and are very massive. At the north end of this shop stores for materials are partitioned off from the rest of the interior. Adjoining are offices, including a spacious and well-lighted draughtsmen's room.

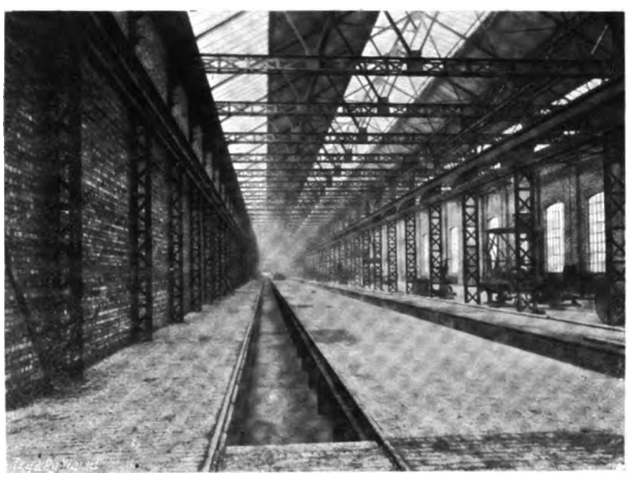

Fig. 70.—Interior of One Bay of Mill Hill Park Car Sheds.

In the main shed in the centre length of the building, which is 70 ft. wide and 18 ft. high to the wall-plate, there are five tracks, with pits 4 ft. deep. The floor of the shed and the pits are of concrete. In fact, there is practically nothing of a combustible nature in the whole structure. Two entire trains can be accommodated on each track. Two overhead travelling cranes can lift a car and shift it about as required. Motor repairing and the wiring of the motors under the cars are carried on here, and an elaborate equipment of tools has been provided.

On the west side is the painting shop, which is of the same breadth and height as the repairing shop, but has not been provided with pits. There are here four tracks. The oil and paint stores form a separate building standing by itself in the yard outside, so that there may be no risk of fire in the main building.

Training of Drivers.—In another building adjoining the car shops a full-sized car has been fitted up for the purpose of training the men who have hitherto been engine-drivers and stokers to their new duties as drivers of the electric trains. Some of the men have had experience of such work on the South Harrow line, but this training car is required for the bulk of the men. The body of the car has, of course, not been completed, but the underframe, trucks, wheels, motors, and all electrical apparatus and connections and brake mechanism have been fitted. The wheels are jacked up so that they may revolve although the car remains stationary, suitable braking arrangements being provided to give the necessary check to the unloaded rotation of the wheels.

THE NEW ROLLING STOCK.

The time-honoured and time-worn carriages of the District Railway are now about to disappear along with the steam locomotives which rendered the air in the tunnels so disagreeable. In their place come the handsome new electric trains. The first of these new trains will probably be running very shortly after this article appears in type, and gradually additional electric trains will be introduced, displacing the steam trains, till the whole of the latter have disappeared.

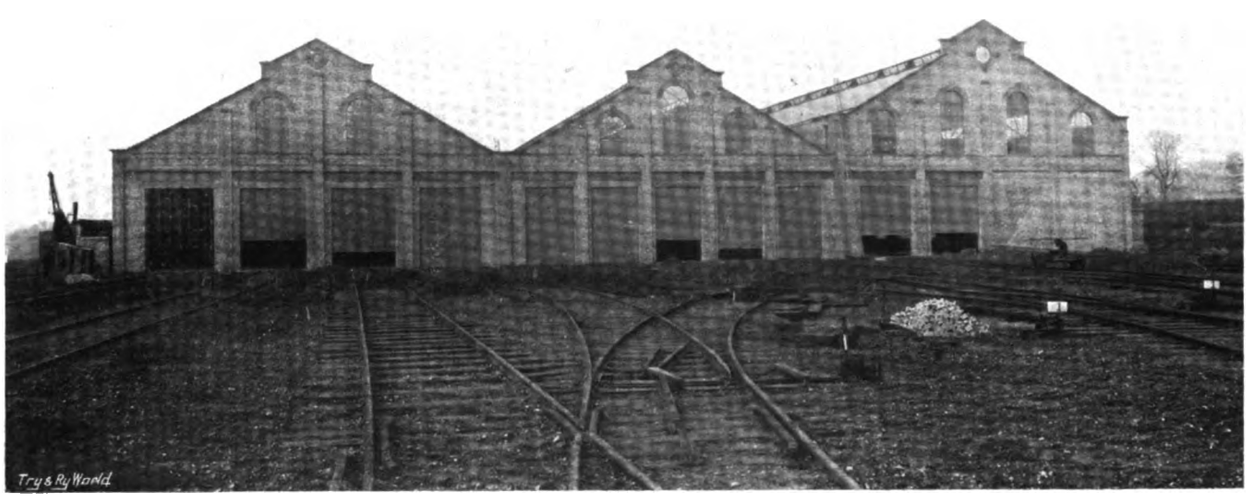

Fig. 69.—End View of Mill Hill Park Car Sheds.

The general design and appearance of the new cars may be gathered from the illustration on page 97 and from Figs. 71 to 73. Each train consists of seven cars, three of which are motor cars and four are trailers. There is a motor car at each end and one in the centre of the train. Each motor car carries two 200 H.P.

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motors on one of its bogie trucks, so that there are six motors per train, giving an aggregate of 1,200 H.P. All the cars are of the same over-all dimensions, namely, 49 ft. 6½ in. long over the buffers, 12 ft. 3¼ in. high from the rail level, and 8 ft. 10½ in. wide over the outside eaves mouldings. Detail dimensions may be gathered from the drawings here reproduced. The total number of cars which have up till now been ordered is 420, making 60 trains of seven cars each. Some of the cars have been built by the Brush Electrical Engineering Company, some by the Metropolitan Amalgamated Railway Carriage and Wagon Company, and the rest by Continental builders. All, however, are to the same designs and specifications, prepared by the engineers of the Underground Railways Company.

The car bodies have several new features, all of which make for the further security of passengers. The end partitions are formed of mild steel plates sandwiched between mahogany frames. These plates are securely fastened to the floor frame, side frame, and roof by means of angle steel bars, which are riveted to steel plates and bolted to the other parts of the frame. This materially strengthens the car ends, preventing telescoping in case of accident. A further prevention against the possibility of the cars telescoping is provided for by the arrangement of deeply cut corrugations across the face of the cast steel buffer blocks, which are placed centrally at the ends of the platforms. The drawbars are of the automatic vertical-plane, radial-coupler type. The underframes are composed of mild steel sections, with wood filling for carrying the floors of the car. The whole of the timber used in the construction of the cars, including internal fittings, mouldings, etc., has been rendered non-inflammable on the system of the Fire Resisting Corporation of Fulham. The Brush Company have laid down a plant at their Loughborough works for treating wood in this way. Externally the sides of the cars right up to the roof-level are sheeted over with aluminium, and then finished with paint of a royal scarlet colour.

The arrangement prevalent on many electric railways by which passengers enter the cars by end platforms has not been adopted. The cars are close-coupled, and the small space between their ends is closed by a pantograph grating. Each car has three doors on each side—a door at either end and one in the centre. These doors slide on ball-bearing rollers, and are worked by compressed air, under the control of the guard of each car. There is a small three-way valve on the platform of each car, communicating with the compressed air supply for the brakes, and by moving a short lever the doors of the car on the side next the station platform are simultaneously either opened or closed. When the train is returning, the doors on the other side of the car are actuated, the power being applicable either to the one side or the other, as required. The doors are moved by pistons working in small pneumatic cylinders. This arrangement has been designed by the Underground Railways Company's engineers, and has not been used anywhere before. The windows of the cars are of heavy plate glass with brilliant cut decorations.

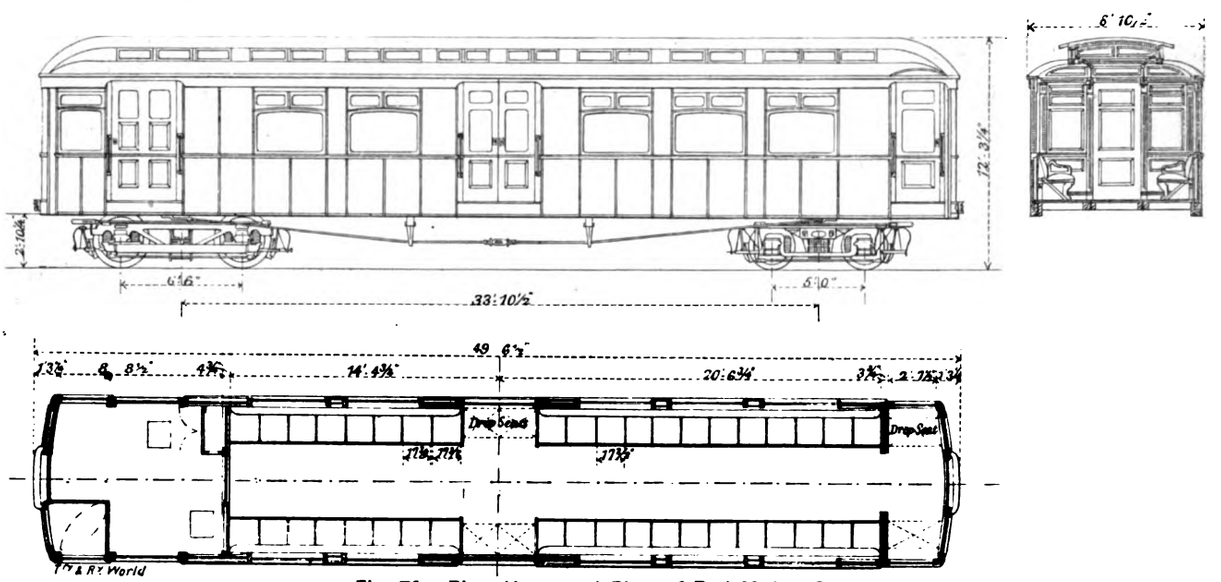

Fig. 71.—Elevations and Plan of End Motor Car.

The motor cars at the ends of the train have drivers' compartments, where the controlling and braking gear is concentrated, and a certain proportion of them have luggage compartments. The motor car in the centre of the train is generally like a trailer car, but there is a hinged door on the platform which is kept open, and covers up behind it a master controller and brake apparatus. If the train is divided, so as to run shorter trains at any time, this centre motor car becomes an end car. The door referred to is then closed, and leaves half the platform as a driver's compartment, from which the motorman works the train.

Most of the seats are arranged longitudinally,

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with a proportion of cross seats. Drop seats are fixed at the central doors, so that they can be used on the side farthest from the station platforms, and dropped out of the way on the other side. Each trailer car and the middle motor car seats 52 passengers, and each end motor car 48 passengers, giving a total seating capacity per train of 356. The space between the fronts of the longitudinal seats is 3 ft. 10 in., so that during times of heavy traffic there is space for a large number of passengers to stand. In most cases the seats are upholstered in rattan which has been rendered non-inflammable. The seat frames and backs are of steel. A certain number of the cars are provided with crimson plush seats, and this plush has also been rendered non-inflammable.

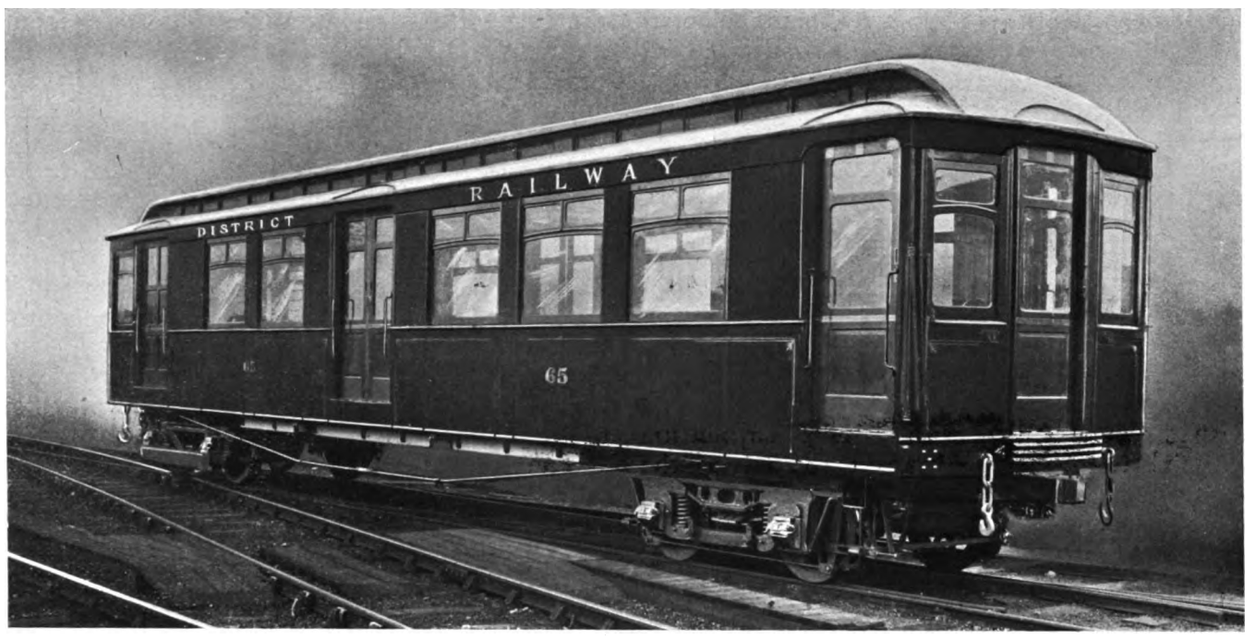

Fig. 72.—End Motor Car.

The interior finish is in mahogany flatted to a dull polish. All mouldings and carvings have been designed with a view to prevent the lodgment of dirt, and to be easily and quickly cleaned. The ceilings are of asbestos millboard, painted white, and beautifully decorated in gold. All the inside metallic fittings are of bronze. The cars will be heated in winter by Gold electric car heaters, supplied by W. S. Laycock, Limited, Sheffield. The ventilators in each side of the clerestory are worked simultaneously by a lever fixed inside the car near the end. The bells are not electric, but mechanical push bells, the connection being a solid wire cord inside a flexible tube. The wire is pushed and pulled, ringing the bell either way.

Fig. 73. Interior of Car.

Each car is brilliantly lighted by from 30 to 35 electric glow lamps of 16 candle-power each. These are arranged in two rows along each side of the clerestory and in groups in the roof. As so much of the railway is in tunnel, great attention has been given to the lighting of the cars, so that reading can be carried on by passengers with perfect ease. The current for lighting is taken from the main supply coming in by the collector shoes on the motor cars from the conductor rails, and is led along the train to all cars by a lighting main or bus. The lamps are wired in groups of five in series, so that each has the normal voltage of 110.

Views of the motor and trailer trucks are given in Figs. 74 and 75, while Figs. 76 and 77 are detail drawings of a motor truck showing the construction of the different parts. The motor truck has cast-steel side frames and is provided with an equalising system of springs on each side of the axle boxes. The swing bogie bolsters are carried on elliptic springs. The trucks for the cars built in this country were supplied by the builders of the

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cars, while the trucks for the Continental cars were supplied also from abroad.

Motors and Control.—The main electrical equipment of the cars, which is supplied by the British Thomson-Houston Company, consists of that firm's 200 H.P. G. E. 69 motors and the Sprague-Thomson-Houston multiple-unit train control. In an early part of this article reference was made to the running of experimental electric trains on the South Harrow line, and it is here of interest to note that the contracts for motors and control equipments for the whole of the new District Railway rolling stock were awarded to the British Thomson-Houston Company after exhaustive tests, extending over a period of eight months. The tests were carried out on the South Harrow line under the supervision of the engineers of the Underground Electric Railways Company.

The motors, an external view of which is given in Fig. 78, are arranged for mounting on an axle with a length of 50 in. between the finished wheel hubs, with a nose suspension designed to rest on a bracket riveted to the truck transom. The motor frame is of the box frame type, with the frame heads carrying the armature shaft bearings, and it is provided with safety lugs to prevent the motor from falling owing to the breaking of the nose. A forged strip is bolted over the top of the nose to prevent the motor from rising. The motor is mounted on, or removed from, the truck from above when the truck is out from under the car, no pit being required. The gear is divided into two halves, with a 7 in. bore arranged to go directly on the axle. The general features of the internal construction of the motors do not differ from their makers' standard practice, and they were described in our issue of April 14, 1904. The weight of one motor complete, together with gearing and gear-case, is about 6,100 lb.

In many respects the Sprague-Thomson-Houston control employed is similar to that described in our pages in January last year in connection with the electrification of the Newcastle lines of the North Eastern Railway, but it embodies some new features. The system of control consists essentially of two parts: First, a series-parallel motor controller consisting of a number of electrically operated switches called "contactors," and an electrically operated reversing switch, called the reverser. The contactors make the different electrical combinations of the motor and regulate the starting resistance in circuit with them. Second, a master controller, situated in the driver's cab of each motor car, which operates the motor controlling contactors, and reverser. A cable connected to each master controller and to the contactors, runs the entire length of the trains, with suitable couplers for making the necessary connections between the cars. From the position of the controller handle the operator is made aware of the exact resistance and motor combinations on all the motor cars. The master controller is operated by hand, and is non-automatic. The motorman, therefore, has the train under his immediate control and, in case of emergency, can utilise the full power of the motors in either direction. The handle of the controller is provided with a device which ensures the opening of the control circuit and the shutting off of all power from the train should the operator release his hold of the handle. Releasing the handle will also open an air valve in the controller, and the air brakes will be applied on all the cars of the train. After applying the brakes by means of this device they may be released by simply depressing the knob at the off position of the handle, and if it is desired to render this air brake device inoperative, it is only necessary to move the reversing handle to the mid position. For reversing the motors the controller is provided with a separate reversing handle, and a mechanical interlocking device prevents this handle from being thrown, unless the main handle is in the off position.

The operating circuit is so arranged that unless the reverser is thrown for the direction of car movement indicated by the master controller reverse handle, the contactors and motors on that particular car are inoperative.

All current for the operation of the contactors on each of the different cars throughout the train passes through the single master controller under the immediate control of the motorman. This current may be taken directly from the collector shoes of the leading car or from the shoes on the following motor car by means of the bus-line, but it is controlled by the single master controller in use. In the event of the train being divided in two the control current is automatically and instantly cut off from the detached rear portion without affecting the ability of the motorman to control the front part of the train.

There are four rheostatic points and one running point in series, and three rheostatic points and one running point in parallel, and the relative resistance for each step is such as to ensure even acceleration of the train. Smooth transition from series to parallel combination is ensured by making the necessary circuit changes without short-circuiting or open-circuiting either motor. The series-parallel arrangement of rheostats is used, which results in the best possible proportioning of resistance sections, and at the same time gives a uniform distribution of current per contactor.

It is interesting to note that these trains are the first in England to use the "bridge" method of changing from series to parallel combination of motors. By this method the change is effected without interrupting the current in either motor, which is maintained at practically a constant value throughout the whole range of rheostatic acceleration. The unpleasant sag in speed, which is noticeable when the motor current is

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interrupted while the motors are passing from series to parallel relation is thus eliminated.

Another of the more modern improvements with which these equipments are provided is the electrically operated carbon-break circuit breaker for the protection of the motor circuit on each motor car. Each circuit breaker is provided with a setting coil by which the circuit-breaker is closed, and a shunt and an overload tripping coil. Once closed by the setting coil, the circuit-breaker is held in the closed position by a mechanical locking device. Either one of the tripping coils will open the circuit-breaker by releasing the locking arrangement. The circuit-breaker is built in the form of a contactor, and is enclosed in a separate sheet-iron asbestos-lined cover. All the circuit-breakers throughout the train are closed by the setting coils, which are energised from one of the control-wires at the off position of the master controller, this wire being energised by the circuit-breaker setting switch in the driving cab. All circuit-breakers may be instantly tripped, whatever the position of the master controller, by merely closing the tripping switch in the cab, thus energising the shunt trip coil of each circuit-breaker. Moreover, any circuit-breaker may be opened automatically through an overload in the motor circuit without affecting the remaining circuit-breakers in the train, simply cutting out of service the motors on that particular car.

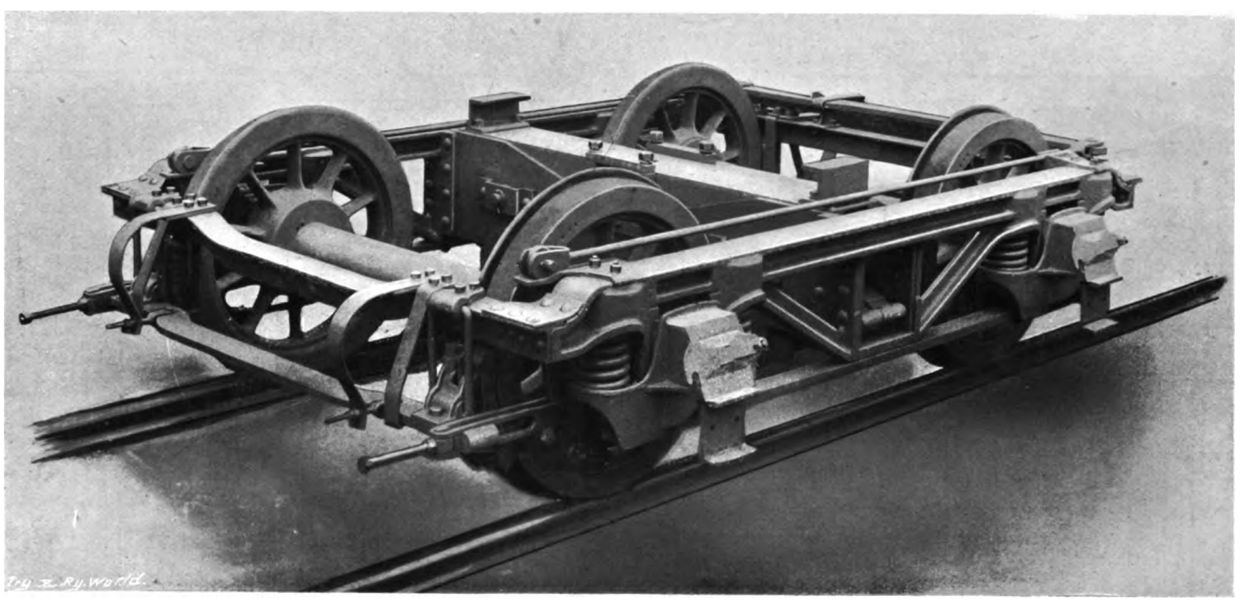

Fig 74.—Motor Truck.

The control cable consists of ten differently coloured, separately insulated conductors for convenience in installation, and is used for the several multiple circuits between couplers, connection boards, master controller, and cut-out switch. The copper strands of the heavy car wiring cables are first wrapped with paper tape. They are then insulated with rubber, taped and served with one cotton and one asbestos braid. A slate-coloured lead paint, containing very little oil, which is practically non-inflammable, is used for finishing.

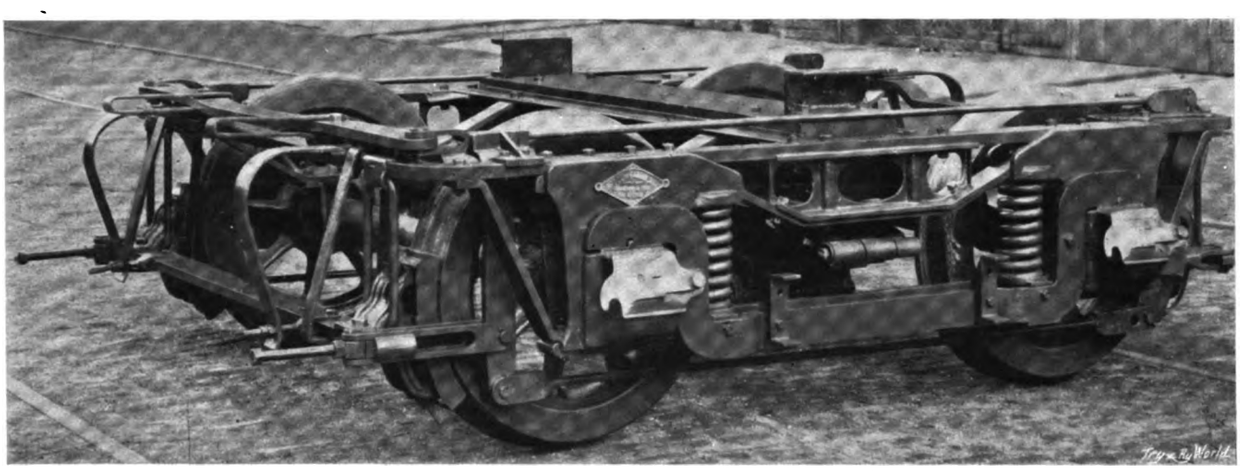

Fig. 75.—Trailer Truck.

The controlling apparatus, air compressors, and governors are supported beneath the car, between the trucks. The controlling apparatus

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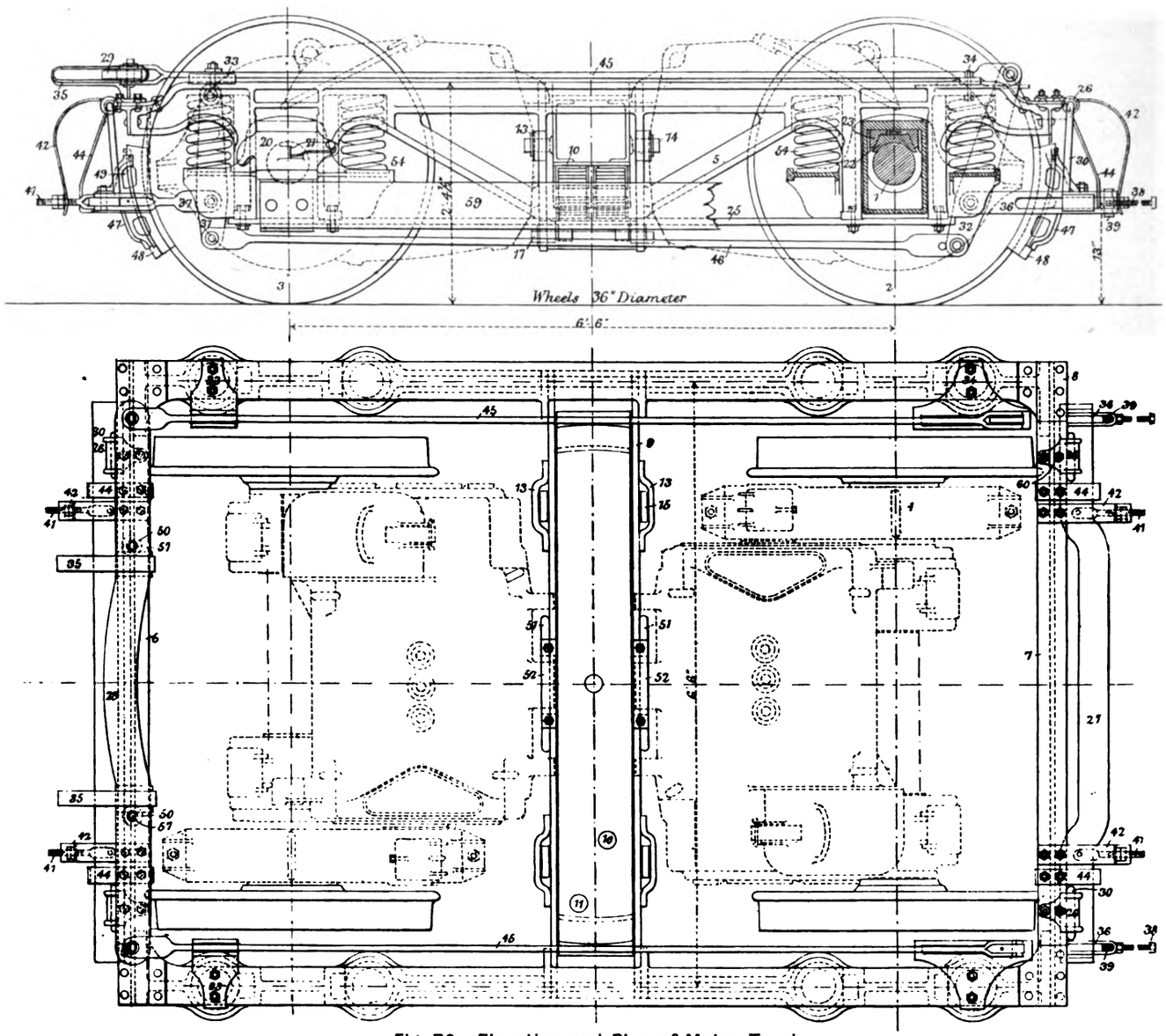

Fig. 76.—Elevation and Plan of Motor Truck.

LIST OF MOTOR TRUCK DETAILS.

Material.	Index.	Description.	Material.	Index.	Description.
Mild steel	1	Axle.	Mild steel	31	Dead lever.
Cast ,, ...	2	Wheel.	,, ,, ...	32	Live ,,
,, ,, ...	3	,,	Cast steel	33	Dead lever support and upper rod guide.
Mild ,, ...	4	Axle key.	,, ,, ...	34	Live lever guide.
Cast ,, ...	5	Side frame.	,, ,, ...	35	Brake rod yoke guide.
Mild ,, ...	6	T. end frame (back).	Mild ,, ...	36	,, beam adjusting link, live lever end.
,, ,, ...	7	,, ,, (front).	,, ,, ...	37	,, ,, ,, ,, dead ,, ,,
,, ,, ...	8	Gusset plate for 5, 6, 7.	,, ,, ...	38	,, ,, ,, screw.
,, ,, ...	9	Swing bolster housing plates.	Cast ,, ...	39	,, ,, ,, ,, nut.
,, ,, ...	10	Swing bolster.	,, ,, ...	40	,, ,, ,, ,, cage.
Cast ,, ...	11	,, ,, side bearing.	Mild ,, ...	41	Adjusting screw for brake beam release spring.
Mild ,, ...	12	Spring plank.	Spring ,, ...	42	Brake beam release spring.
,, ,, ...	13	Support for do.	Mild ,, ...	43	,, ,, ,, ,, backing.
,, ,, ...	14	Cotter pin for do. hangers.	,, ,, ...	44	,, ,, safety guard.
Cast ,, ...	15	Spring plank hanger.	,, ,, ...	45	,, rod (upper).
,, ,, ...	16	,, ,, bearing pocket.	,, ,, ...	46	,, ,, (lower).
Mild ,, ...	17	,, ,, ,, ,, pin.	Cast ,, ...	47	,, head.
,, ,, ...	18	,, ,, safety guard.	Grey iron	48	,, shoe.
Cast ,, ...	19	Journal box.	Mild steel	49	,, ,, and head key.
Mall. cast iron ...	20	,, ,, cover.	Cast ,, ...	50	,, rod yoke roller.
Spring steel ...	21	,, ,, ,, spring	,, ,, ...	51	Motor horn support.
Bronze	22	,, brass.	Mild ,, ...	52	,, ,, ,, keeper.
Cast steel	23	,, wedge.	Spring ,, ...	53	Elliptical springs.
Bronze	24	,, ,, liner.	,, ,, ...	54	Spiral equalising springs.
Mild steel	25	Pedestal tie bar.	Mild ,, ...	55	Cotter pin for 31 and 33.
Cast ,, ...	26	Brake beam link support.	,, ,, ...	56	,, ,, 31, 28, 32, 36, 37, 45, 46.
Mild ,, ...	27	,, ,, live lever end.	,, ,, ...	57	Brake rod yoke roller pin.
,, ,, ...	28	,, ,, dead ,, ,,	Elm	58	Journal dust guard.
,, ,, ...	29	,, rod yoke.	Oak...	59	Trolley shoe bracket beam.
,, ,, ...	30	,, beam link.	Cast iron	60	Backing strip for brake beam link support.

is all enclosed in well insulated metal covers, supported on hard wooden beams. The main wiring is enclosed in drawn steel tubes, and the rheostat and contactor leads are supported in wooden troughs lined with uralite.

Though in ordinary running each motor car

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collects its own current by the usual contact shoes from the third rail and returns it by the negative shoes to the fourth rail, it is necessary to provide for all the motors on the train being supplied through the collector shoes of one motor car. This arises from the fact that there are so many junctions, sidings, and cross-overs on the railway where gaps have to be left in the conductor rails. When the shoes of any motor car are over a gap, the motors on that car are supplied from the other motor cars by the power cable which runs the entire length of the train.

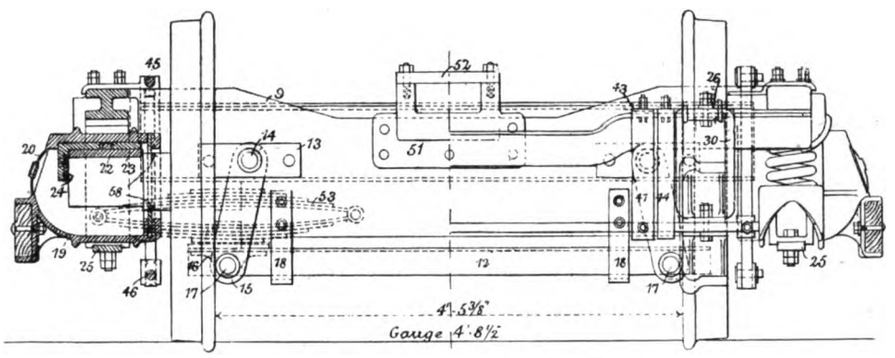

Fig. 77.—Cross Section of Motor Truck.

The arrangement and construction of the bodies and trucks and of their electrical equipment have been under the supervision of Mr. F. D. Ward, for the Underground Electric Railways Company.

RUNNING ARRANGEMENTS.

It is as yet too early to say definitely how all the traffic will be arranged as it develops, but the general scheme of running may be indicated. The motors on each train are of sufficient power to produce a train acceleration of 1·46 ft. per second per second on starting from rest. The train weight, without passengers, is about 160 tons. The average speed, including stops, will vary on the different routes according to the distances between stations. Taking the District Railway all over, the speed, including stops, will be from 16½ to 17 miles per hour. On the Inner Circle it will be about 15½ miles an hour, a journey round the Circle, 13·07 miles in length, occupying 50 minutes, as against 70 minutes required by the steam trains hitherto used. On some of the suburban routes, where the stations are further apart, the average speed will be from 18 to 20 miles an hour. Where the stations are separated by intervals of about a mile or more, the maximum speed reached between them will be nearly 30 miles an hour.

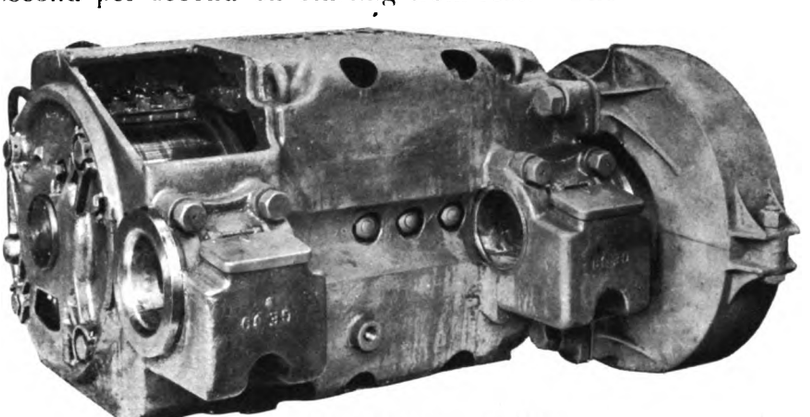

Fig. 78.—200 H.P. Motor. Back View.

Hitherto the most frequent service of trains on the District Company's part of the Inner Circle has been a train each way every three minutes. It is proposed, when the electric service is in full operation, to more than double this service by running 40 trains an hour in each direction. As to the service round the whole Circle, the District Company will run a train every ten minutes in each direction. The Metropolitan Railway Company will do likewise, so that there will be a Circle train every five minutes each way.

ELECTRIFIED RAILWAYS IN ENGLAND.

The following shows the route lengths of all the electric railways in England which were formerly worked by steam traction. All the lines are double track.

	Miles.
Mersey Railway	4
Lancashire and Yorkshire Railway (Liverpool to Crossens)	30
North Eastern Railway (Newcastle lines)	40
Metropolitan Railway	25
Metropolitan District Railway	41
Total	140

CONCLUSION.

In conclusion, we have to express our great indebtedness to Mr. Jas. R. Chapman, engineer-in-chief and general manager of the Underground Electric Railways Company of London, under whose designs and guidance the whole great undertaking has been carried out, for the facilities and information which he has placed at our disposal; and to those associated with him in the work, including Mr. J. W. Towle, engineer at the power-station; Mr. S. B. Fortenbaugh, electrical engineer of the Underground Railways Company; Mr. W. E. Hanson, who has been responsible for the permanent way equipment and laying of the feeders; Mr. C. E. Strange, who has had charge of the signalling installation; and Mr. F. D. Ward, master mechanic of the line, under whose charge are the rolling stock and repair sheds at Mill Hill Park. For the assistance rendered by Mr. John Young, general manager of the Metropolitan District Railway, we also express our hearty thanks, and we have further to acknowledge our great obligations to the manufacturers and contractors who furnished us with details of work carried out by them.

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THE

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District Railway Electrification.

We devote a large part of the present issue to an account of the electrical equipment of the Metropolitan District Railway, and of that deeply interesting undertaking, the great power-station at Chelsea. To permit of the publication of the whole description it has been necessary not only to exclude much other matter which would otherwise have received attention in this issue, but also to extend our space considerably beyond the usual limits. The arrangement has its disadvantages, but we believe that readers will appreciate the convenience of receiving in a single issue a comprehensive account of what is in some respects the most elaborate electrical installation which has yet been undertaken. No one can read the description in the foregoing pages without being impressed with the extraordinary character of the installation. To design a power-station with a capacity of 80,000 horse-power is not, of course, an unparalleled accomplishment. New York City possesses at least two stations of equal or greater capacity; but the systems of railways for which they supply energy is far less complex than the net-work of underground railways to be worked from Chelsea. As a consequence the feeder system and the corresponding connections at the sub-stations and at Chelsea station presented problems of the most exacting character. In the solution of these problems the engineers have with respect to many important details been obliged to work out entirely new designs. Contractors have in some cases been called upon simply to follow instructions from headquarters; in others their standard designs have been modified by the engineers to suit the novel requirements of an unprecedented work.

* * *

The engineers have throughout had the courage of their convictions, and the result is that Chelsea station, apart from its size, is one of the greatest interest from an engineer's point of view. The use of the immense turbine units running at the high speed of 1,000 revolutions per minute would alone make the station notable for years to come. There under favourable conditions the steam turbine will in a few years receive such searching tests as will exactly establish its relative advantages as compared with the more familiar reciprocating engine. Of the result few engineers probably entertain any doubt, but the working of Chelsea station will give quantitative results of the greatest value. Of the skill with which the whole immensely complicated equipment of track, feeder systems, and station have been designed it is difficult to speak with moderation. Privileged as we have been to observe the work in its various stages, we have been profoundly impressed with the care with which every detail of the undertaking has been worked out, and with the energy and rapidity which have characterised the execution from the outset. Considering the exceedingly difficult conditions under which work upon the track and in the tunnel had to be done, it is simply astonishing that the engineers are to-day so near the completion of their task. While London has scarcely known of any change, a revolution in its methods of travel has been prepared which will place it in a few short months abreast, if not ahead, of any other city.

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The Speed of Tramcars.

The agitation in favour of increased speed on tramways has been going on ever since electrical traction was introduced. It has been an increasingly difficult task to move the *vis inertiae* of those Government departments which consider that the safety of the public is in their especial keeping. This same public is getting more and more used to taking care of itself on public roads; this is evident from the very small number of running-down accidents due to tramcars, a number which has diminished year by year, in spite of the increase in the density of the population in all cities, and of the additional lines opened and cars run year by year. The automobilists being well represented in Parliament, and speaking with one voice, have succeeded in getting their maximum speed raised to 20 miles, and will probably get more. The motor 'buses which, when this concession was granted, had not come on the scene in sufficient numbers to be taken into consideration, are now profiting from the efforts of the light brigade which has gone before and cleared the ground of obstacles, for which they are to be congratulated and cannot be blamed in any way. Railway companies are still complaining of the competition of municipal tramcars run, in a measure, at their own expense; they have the remedy in their own hands, and have only to follow the example of the District Railway and the London United Tramways, and by agreeing with their adversary quickly, turn a competitor into a powerful feeder to their own lines.

* * *

No such easy way out of the difficulty is open to the tramways in dealing with the competition of the motor omnibuses. The difficulties lie entirely with the Board of Trade and with the worthy but inexperienced military men who are mainly responsible for its actions. The case for the tramways is put most temperately and forcibly by the Tramways and Light Railways Association in their correspondence with the Department. On another page we give their last letter to the Board, the arguments in which that slow-moving body will have some difficulty in answering. At present, as pointed out by the secretary of the Association, motor omnibuses are allowed to go as they please in the centre of London, while tramcars are tied down to growler-speeds even in the outskirts. All the tramways ask for is a fair field and no favour, and let the best vehicle win. At present they see the 'buses pass them on roads towards the up-keep of which they (the 'buses) do not contribute, and which they wear out at the expense of the tramways. The situation is intolerable, and it is to be hoped that the Association, representing as they fully do, both private and municipal interests, will succeed in attaining the very just objects of their agitation in favour of equality of treatment and consequent increase of speed.

The Control of the Staff.

Those who sincerely desire the success of municipal tramways will have noted with much regret the decision of the Tramways Committee of Bradford Corporation to allow employees dismissed by the manager to appeal to the Committee for re-instatement. The exact rules under which appeals may be made, and the method of investigation by the Committee have not yet been determined, but however carefully the rules are framed the change is bound, we fear, to introduce friction and to diminish the efficiency of the management. This question has been repeatedly discussed in these pages, but we would once more urge tramway committees who may be contemplating such a procedure to consult the opinion of the Municipal Tramways Association. That body includes both chairmen and managers, and is well fitted to consider the matter impartially. It should not be forgotten that a number of the largest Corporations have recognised the principle that the greatest efficiency can be attained only when the manager is alone responsible for discipline. When managers were quite recently appointed in Glasgow and Belfast it was expressly provided that the manager should be the final authority; and if the manager be an experienced and capable man—qualifications without which his appointment would not have been made—it is difficult to understand what objection can be shown to arming him with full disciplinary powers. The competent manager has nothing to gain and much to lose by changes in his staff; but when these are necessary he should be in a position to make them with the least possible

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fuss and as rapidly as possible. Such a change as that proposed at Bradford will add immensely to the difficulties of management; but it may also have an important influence on the composition of tramway committees. Few councillors will probably care to waste their time and energy in performing duties which properly belong to the executive head of the department, and the result will be that the best men in the councils will seek to be relieved of tramway work. We do not wish to pose as alarmists; but those who are intimately acquainted with changes now taking place in the methods of town councils are fully aware that it is most desirable not to make the members directly responsible for the employment or dismissal of the tramway staff. To do otherwise is likely to lead to abuses such as prevail in many American cities, and to render local politics distasteful to the better class of citizens.

The Purchase of Depots.

The case of the Swinton and Pendlebury District Council and the Manchester Carriage and Tramway Company, Limited, which was argued recently before the Court of Appeal, although of undoubted importance, is far from being of the importance attached to it in some quarters. At a period, when conversion of old-fashioned horse tramways into electrical undertakings has been proceeding throughout the country, through the operation of Section 43 of the Tramways Act of 1870, any decision on this section is, of course, of consequence; but vendors, in our opinion, need not take alarm at the actual decision in this case. The section, as is well known, entitles the local authority to give notice in writing to purchase an undertaking within six months after the expiration of a period of twenty-one years from the time when such promoters were empowered to construct such tramway, and "thereupon such promoters," says the section, "shall sell to them their undertaking, or so much of the same as is within such district, upon terms of paying the then value (exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale or other consideration whatsoever) of the tramway, and all lands, buildings, works, materials, and plant of the promoters suitable to and used by them for the purposes of their undertaking within such district." In the case in question the local authority had given the notice that the statute required to purchase the undertaking of the Manchester Carriage and Tramway Company, Limited, and the matter had been referred to the late Sir Frederick Bramwell, as arbitrator, to determine the price that the local authority should pay. Outside the district there were two depôts, one of which the arbitrator had found unsuitable, and in respect of the other he had found it suitable, but it was extremely doubtful whether it was used, "for the purposes of the undertaking within the district." Since it was impossible to refer the matter to the arbitrator, the Court of Appeal held that all the three requirements of the section were not fulfilled, that is to say, it had not been found that the (1) depôt was suitable to (2) and used by the company (3) for the purposes of their undertaking within such district. This is, of course, far from being a decision—that a local authority are unable to purchase lands, buildings, works, materials, and plant if they happen to be situate outside their district. Indeed, such a construction would be disastrous to vendors, and it is believed in many cases would prove unfortunate for local authorities purchasing, since it must be obvious that if land and buildings which have been for years used for an undertaking, and which are in every respect suitable for the purpose, can not be purchased by reason of the accident that they happen to fall a few feet outside a local authority's jurisdiction, these bodies would suffer the hardship of being compelled to acquire and erect buildings at a price probably considerably higher than that for which they could have acquired land and buildings in every respect suitable to the undertaking, but unfortunately situate just outside their jurisdiction. In our opinion no such narrow construction can be placed upon the section, and it certainly has not been so placed by the decision of the Court of Appeal.

South Eastern Railway and Tramway Competition. Mr. H. Cosmo Bonsor, speaking at the meeting of South Eastern Railway shareholders on the 30th ult., said that passenger traffic continued to decrease. They had carried in the last six months of 1904 2,100,000 passengers fewer than in the corresponding period of 1903, and this represented a loss of something like £20,000. They were feeling more strongly than ever the competition of the rate-aided tramways, with which they could never hope to compete. The only way they could meet this competition was by taking off a number of workmen's trains and partially closing some of the stations.

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TRAMWAY SPEED LIMITS AND THE BOARD OF TRADE.

At the end of last year the Tramways and Light Railways Association, addressed the Board of Trade giving reasons why, in their opinion, the speed limits on tramways should not be more stringent than those for motor cars or motor omnibuses. To this the Board of Trade replied on December 28, 1904, as follows:

"I am directed by the Board of Trade to advert to your letter of the 2nd instant, representing, on behalf of the Council of the Tramways and Light Railways Association, that the speed limits on tramways should not be more restricted than those allowed for motor cars, including motor omnibuses, in the same road; and suggesting that the Board of Trade should, as a general rule, adopt the speed limit of twenty miles an hour in the regulations made by them for electrically-worked lines on public roads.

"In reply, I am to say that the view expressed in your letter, viz., that, except on very sharp gradients, tramcars may safely be allowed to run at as high a speed as motor cars, is one which the Board of Trade, as advised, are unable to accept.

"The question of prescribing a general speed-limit for tramcars has frequently been considered by the Board, and reference may be made to a meeting held at this office in July, 1902, at which the principal municipal tramway proprietors were represented, when this subject was fully discussed.

"The Board are of opinion that, in order properly to discharge the duties in this matter imposed upon them by Parliament, so that the public safety may be adequately safeguarded, and at the same time the highest speed [be] authorised consistent with such safely, it is necessary to maintain their present practice of dealing with each route according to the special circumstances affecting it.

"The Board's regulations, therefore, as your Council are aware, do not impose any fixed maximum for all tramways, or for the whole of any one tramway system, but are made on the recommendations of the officers who, after inspecting the several lines on behalf of the department, advise different maximum speeds on different sections in view of the circumstances of each case.

"The Board are desirous of assisting tramway enterprise, and promoting the public convenience in this as in other matters, and they do not fail to have regard to all such circumstances as warrant relatively high speeds in certain cases. They will be ready to proceed in the same spirit in future, and to consider carefully any increase of maximum speed which the body responsible for the safe working of a particular line may feel justified in proposing."

To this the Tramways and Light Railways Association have sent the following reply:

"I am directed by the Council of the Tramways and Light Railways Association to acknowledge Sir Herbert Jekyll's letter of December 28, and while thanking him for his courtesy in explaining the views of the Board's advisers, to express the very great regret of the Council that the Board do not see their way to generally increase the speed limits now enforced by the Board's regulations. The great stringency of those limits has seriously hampered the tramway industry in Great Britain and Ireland, and has helped to render the return on capital less than in any other country. So long as rapid locomotion on the public roads was a novelty to Englishmen my Council could understand the reluctance of the Board to do anything which might be in advance of public opinion. But circumstances have changed. A greater speed has been recognised as safe for the other motor-driven vehicles both by Parliament and the public, and the tramway alone is hampered by obsolete limitations.

"My Council contains a number of men who are in actual control of tramways, whereas, so far as I am aware, none of the advisers of the Board have had the same practical experience. It is the deliberate and unanimous opinion of my Council that the present speed limits could be generally extended without any risk to the public safety. It is also their opinion that the tramcar is in every way a safer vehicle than the motor omnibus, or any other autocar of similar weight, and they would do their best, if the Board desire, to organise tests of comparative stopping power, which might guide the Board in seeing whether their opinion is correct.

"Members of my Council have taken observations as to the speeds of motor omnibuses now running in West London. A motor omnibus has been timed to go from Piccadilly Circus to Kensington Church, a distance of over 2 miles 1,000 yards, in thirteen minutes. This represents a speed, inclusive of stops, of over 12 miles an hour. When allowance is made for stops and for slackening in the crowded parts of Piccadilly and Knightsbridge, this must have meant a running speed, for parts of the journey, of considerably over 14 miles an hour. This speed has been maintained with perfect safety and to the great convenience of the public.

"Now compare the speeds granted by the Board of Trade to London tramways. The maximum running speed on the London County Council tramways does not exceed 10 miles, except for a small stretch near Clapham Common, and is limited to 8, 6, and 4 miles an hour at other places. The maximum running speed on the London United lines is 12 miles an hour on about 6 miles only of the 35 route-miles in operation, and on the remaining 29 miles 10 miles or less, though, as the Board are aware, none of these tramways are within 4 miles of Charing Cross. Similar limits have been laid down for the East London suburbs. In the northern suburbs the Metropolitan Company were recently refused a speed limit of 16 miles an hour between Edgware and Cricklewood, on a road where it would be considered absurd to cut down motor-cars to that limit. Thus we have in London the curious contrast of a high speed for public service cars (other than trams) in crowded central streets and a low speed for trams in outlying suburbs.

"My Council have noticed that when proposals are made by local authorities to limit the speed of motor-cars the Local Government Board grant local enquiries, at which the force and reality of the objections to speed are tested by evidence My Council respectfully ask that, even if the Board refuse to proceed by general regulations, where any tramway company or municipality ask for an increased speed limit the Board of Trade should not refuse the request except on the written report of a responsible officer, after a local enquiry, that such increase would in his opinion be inconsistent with the public safety."

REGULATIONS FOR TRAMWAY CONSTRUCTION AND EQUIPMENT.

The Board of Trade have issued the following revised memorandum on certain details of construction and equipment of electric tramways and light railways laid on public roads:

(1.) CLEARANCE.

The space between the inner rails of a double line must depend upon the overhang of the cars. It is, however, necessary that there should be at least 15 in. between the sides of passing cars, and also a similar space between the side of a car and any standing work such as lamp, telegraph, and trolley wire posts in a street. There should be at least 15 in. between the side of a car and the kerb, whether on straight or curved roads. The clearance between the top deck of cars and the under side of bridges should not be less than 6 ft. 6 in.

(2.) POSTS AND BRACKETS.

Centre posts should not be used without the consent, in every case, of the Board of Trade. The stone kerbing round centre posts should not be such as to enable any person to stand upon it as a refuge, unless the clearance is ample for safety. Where bracket arms 16 ft. in length will not suffice, it is desirable that span wire construction should be used.

(3.) PERMANENT WAY.

The weight of rails should not be less than 90 lb. per yard, 100 lb. being preferred. The groove of the rail should not exceed one and an eighth inch in width, but a groove not exceeding one and a quarter inch will be accepted on curves of less than one chain radius. The details of permanent way and mode of construction as approved by the Board of Trade should not be varied at any time without the Board's consent.

(4.) CARS.

Staircases of the "reversed" type should be avoided, more especially on narrow gauge lines. Of existing types, the "trigger" lifeguard is the pattern which is preferred. The hanging gate should be as close to the ground as possible, and there should be at least 3 ft. between it and the front of the guard. Both the guard and the gate should be at least as wide as the outside of the frame of the truck. In order not to interfere with the efficiency of the lifeguard it is desirable that folding steps should be adopted on all new cars.

The use of covers for the top deck of cars cannot be approved in cases where the gauge of lines is 3 ft. 6 in. or less. Top deck railings should be at least 3 ft. 6 in. high.

The trolley standard must be connected with earth by a low resistance fuse or automatic switch, and the warning signal, when the fuse or switch opens, should be an electric bell. Where trolley ropes cannot be dispensed with or tied up, precautions must be taken to prevent the "slack" causing accidents. To prevent trolley booms being pulled out or trolley standards broken, "traps" should be minimised and detachable trolley heads provided.

No material alterations should be made in cars after inspection, nor any fresh type of car adopted, without the consent of the Board of Trade.

HAWKEYE WRENCH.—We have received from Mr. Walter P. Notcutt, of 19 and 20, Holborn Viaduct, E.C., the British representative of the Hawkeye Wrench Company, a sample of a useful wrench, which will be found very serviceable in tramway work. This wrench is 8 in. long, and is made from 50-point open-hearth carbon steel, case-hardened. This gives it great strength of jaw. The wrench is an almost universal tool, for besides fitting different sized nuts it is also a pipe wrench, and in addition there are dies for renovating the old threads of bolts when they become damaged

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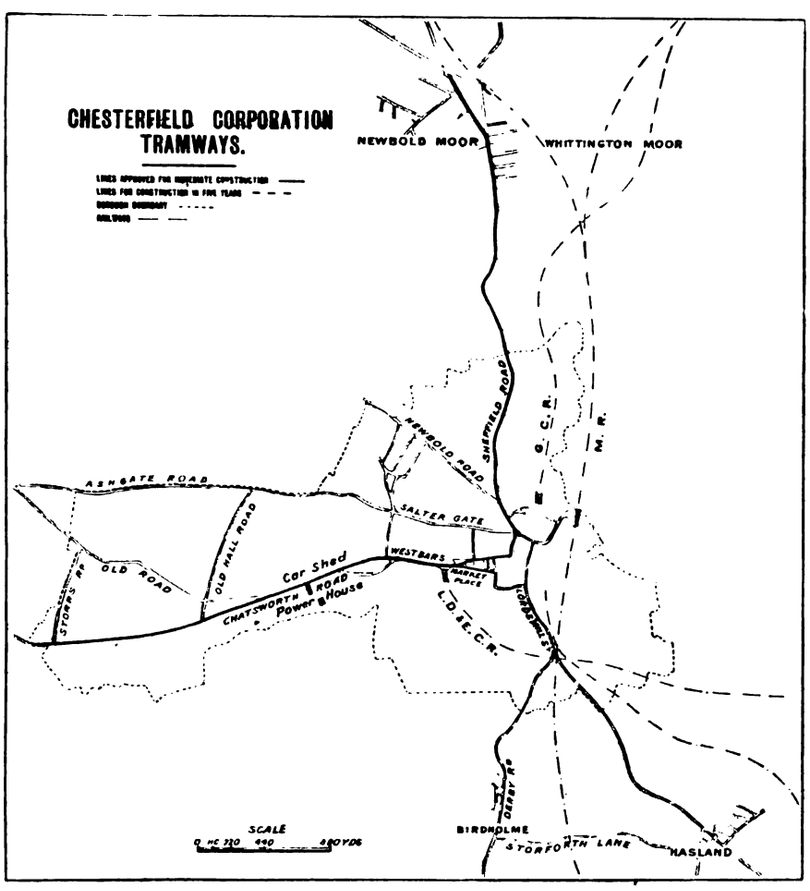
CHESTERFIELD CORPORATION TRAMWAYS.

Chesterfield Corporation has now to be added to the growing list of municipal authorities that own and work electric tramways. The new undertaking is not in any sense pretentious, nor is it characterised by any radical departure from established practice. On the contrary, it has been designed simply to meet the immediate needs of the town, and to meet them with as great efficiency and economy as possible. For this reason standard designs and appliances have, with one exception, been employed. This exception consists in the use of the radial truck which, as readers are aware, is being tried experimentally on several other lines. For the rest, everything has the advantage of well proved excellence.



The Corporation has possessed an electric lighting system since October, 1901, and the tramways have been planned by, and constructed under the supervision of the borough electrical engineer, Mr. R. L. Acland, who has now been appointed also tramway manager. A new unit has been installed in the lighting station, and such other changes have been made as were required by the tramway service. The result is that every inch in the power-station has been made use of; but owing to the convenient arrangement of the station the work there can be carried on efficiently and comfortably.

The story of tramway development at Chesterfield is very much like that of other smaller towns. A horse tramway, which was constructed as early as 1880, by the Chesterfield and District Tramway Company, served the public well without obtaining much return in the form of dividends, and after a somewhat discouraging existence of 17 years, the shareholders were glad to dispose of their property to the Corporation for a very modest sum. As a municipal undertaking with small capitalisation, the tramways proved remunerative, and with the advent of electric traction their conversion was, of course, only a question of time. Town Councils, however, move leisurely, and the project for the conversion of the tramways matured slowly; but in April, 1903, the initial step was taken which culminated on December 20, 1904, in the opening of the first electric tramway in Chesterfield.

Early in 1903 the borough electrical engineer presented an estimate and report advising the conversion of the existing tramways, and the construction of certain extensions within the borough. Subsequently a report embracing a more comprehensive scheme was submitted, and this scheme was finally embodied in the Bill promoted by the Corporation in 1904. As some difference of opinion existed as to what powers should be sought, it was decided to call in Mr. T. B. Goodyer, general manager of the Croydon Tramways, who in his report approved the routes recommended by Mr. Acland. The routes thus recommended were adopted by the Council as reported in our issue of October 8, 1903. Parliamentary sanction for the undertaking was obtained in the Chesterfield Tramways and Improvement Act of 1904. Contracts for the work were let in July of that year. Street work was commenced on August 8, and by Christmas practically the whole of the lines were ready for traffic. The contractors for the construction of the permanent way, overhead work, and feeder system were the British Insulated and Helsby Cables, Limited.

The total length of route is about 3·5 miles, of which 2·25 are entirely new routes, the remainder being the converted horse tramways. The main line, as shown on the map, begins in the Chatsworth Road at a point just within the borough boundary, follows that road to the Market Place, passing the power-station and car shed *en route*.

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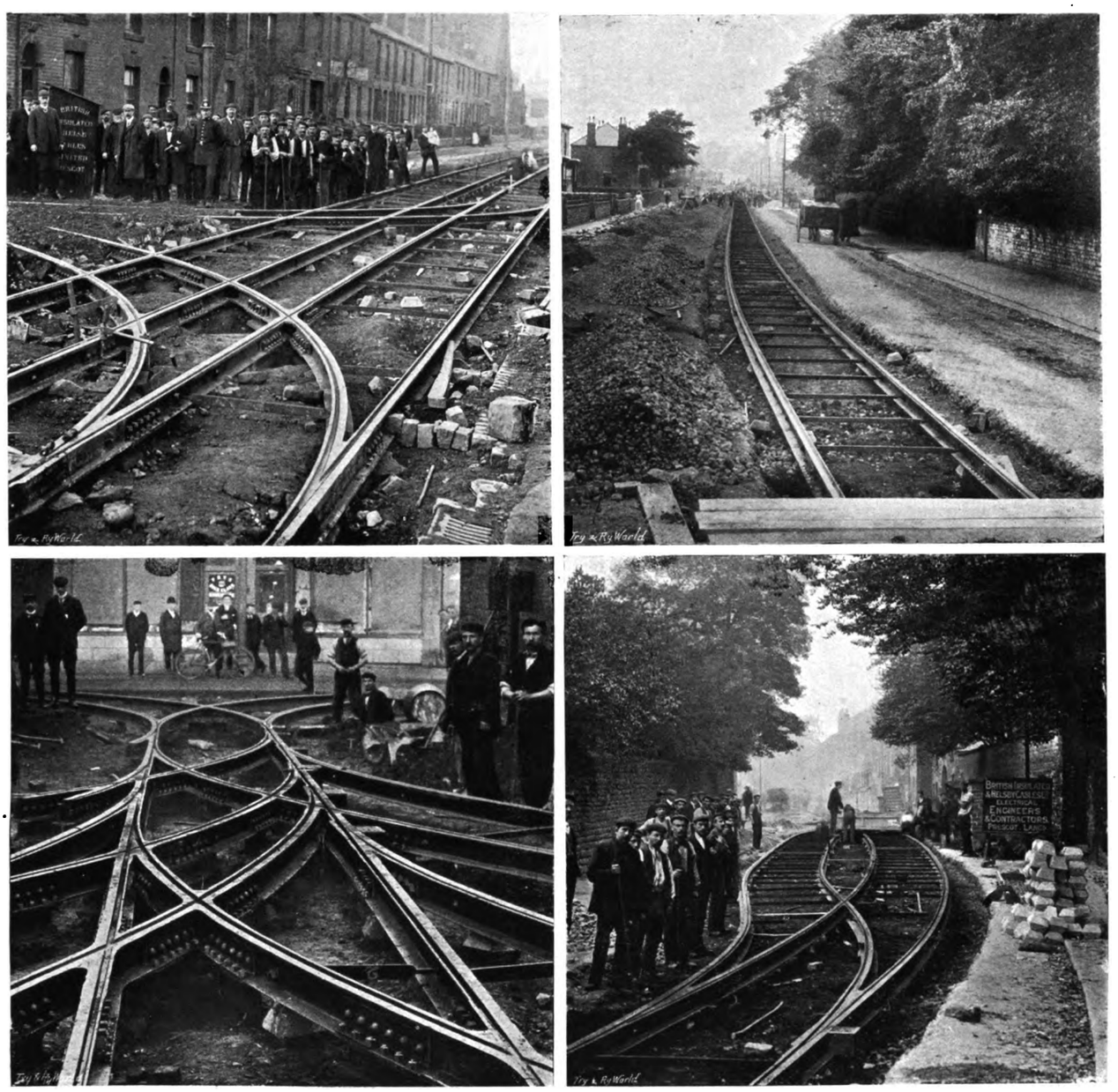
At the Market Place the main line turns to the left and runs diagonally across New Square, thence along High Street, etc., until Sheffield Road is reached, along which it continues through Wittington Moor to a point near the Sheepbridge Station of the Midland Railway. The branch line, which has yet to be constructed, will leave the main line at New Square and run along Derby Road and to Haslan.

Steel Company, of Middlesbrough. The fish-plates are reinforced by Cooper anchor joints. All points and special track work have been made by Hadfield's Steel Foundry Company, and Messrs. Edgar Allen and Company have supplied the drain rails. Tie bars, supplied by Baylis, Jones, and Baylis, are 2 in. by ¼ in.

The track is laid on a foundation of 6 to 1 concrete, averaging 9 in. in depth. Both granite



Views of Permanent Way under Construction—Chesterfield Tramways.

With the single exception of an incline of 1 in 20 for 150 yards, the lines are practically without gradients or curves of inconvenient radii, the sharpest curve having a radius of 48 ft. 6 in. Through the centre of the town a double track has been laid through streets only 20 ft. wide, leaving 3 ft. 4 in. between rail and curb. The gauge is standard, and the rails and fish-plates are of British standard No. 2 section and composition, supplied by the North Eastern

and wood paving are used, the former being grouted with pitch, and the latter, resting on 1 in. of cement floating, is grouted with pitch and cement. Each rail joint is doubly bonded with 4/0 B and S bonds 12 in. in length, supplied by the Forest City Electric Company. Cross bonds of the same gauge have been put in at intervals of 40 yards.

In the overhead equipment both side poles and span wires have been used for supporting

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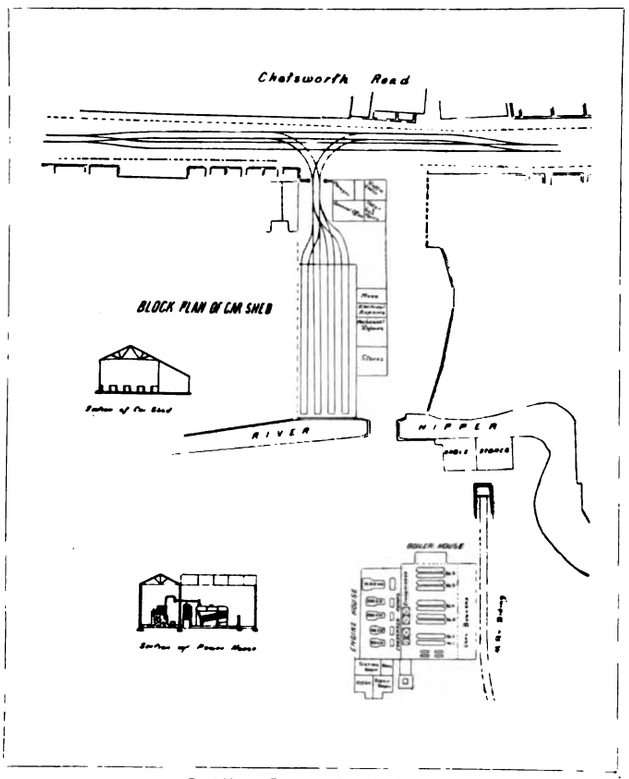
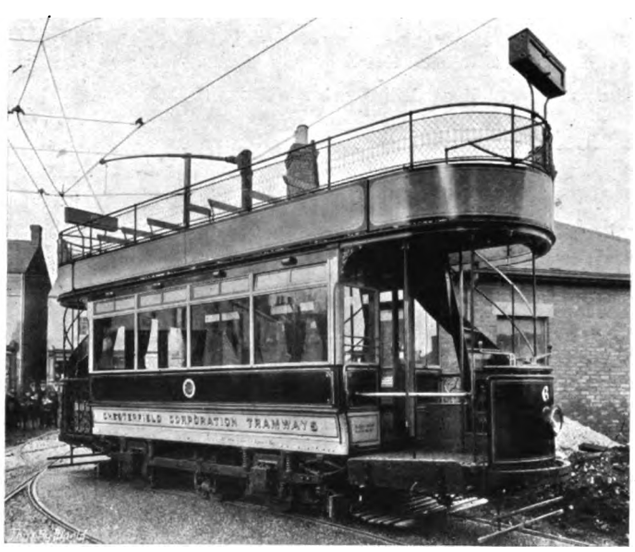
the trolley wire. Swivelling trolley heads are used, but the outreach of the trolley pole is very small, as the trolley wires, which are double throughout the routes, are practically central.



Outline Plan of Station.

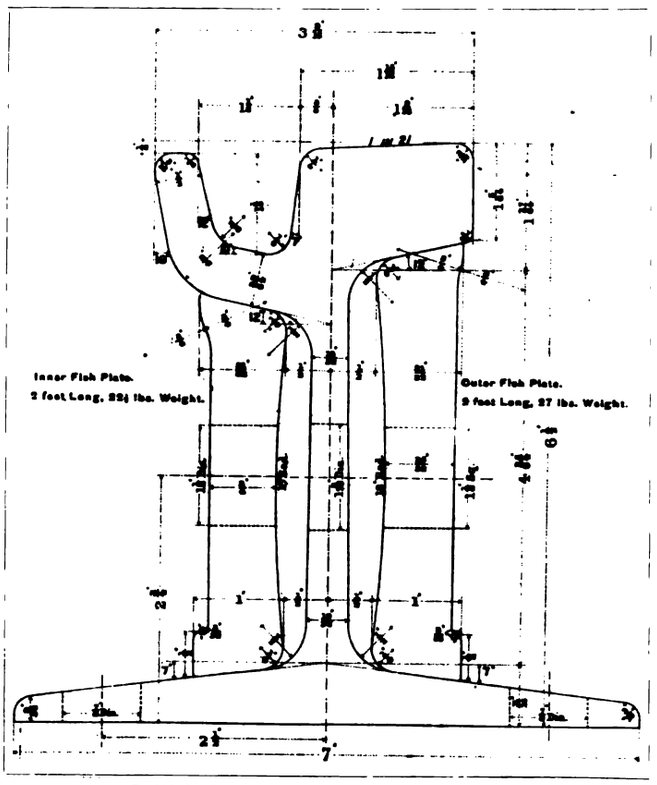
The trolley wires are of 4/0 gauge and they have a breaking strain of 6,586 lbs. Grooved trolley wires and mechanical ears have been used throughout. All span wires are of 7/12 S. W. gauge and guard wires are of 7/14 S. W. G. The poles, which are placed at intervals of 40



Chesterfield Car with Folding Step.

yards, are in three sections, and have been supplied by Spencer and Company, of Wednesbury. Brackets vary in length from 6 ft. to 20 ft.

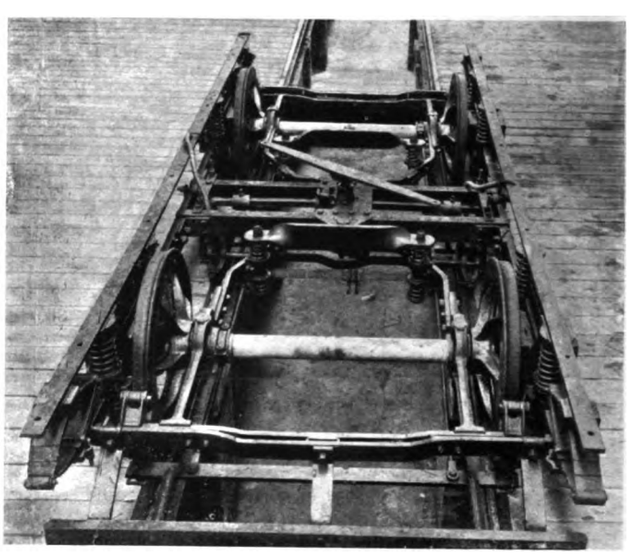
Feeders have been laid from the power-station to the centre of each one-mile section. They are five in number, and range from ·15 to ·4 section, and are of the B.I.W. lead-covered type. The return feeders are ·4, ·3, and ·2. A portion of the cables are paper insulated and armoured,



British Standard Rail. No. 2 Section.

and laid direct in the ground, the remainder being plain lead-covered and drawn into Sykes conduits.

The power-station, as shown on the map, is situated about one mile from one end of the line. It is a plain brick building 75 ft. in length and



Radial Truck.

98 ft. in breadth, with a brick chimney 120 ft. high.

In the boiler-room are six Babcock and Wilcox boilers, with a total heating surface of 10,645 sq. ft. The boilers work at a pressure of 150 lb.,

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and are hand fired. Economisers of 180 tubes each have been supplied both by Green and Clay Cross, and they are motor driven. Worthington feed water pumps and Berryman feed water heaters have been installed. The steam piping, by Aiton and Company, consists of a 10 in. main divided in the centre, with leads to each engine and boiler. Condensers are of the Worthington jet type. Feed water is obtained from the river. The coal used is fine slack, which is delivered at a private siding, the average price being 4s. per ton.

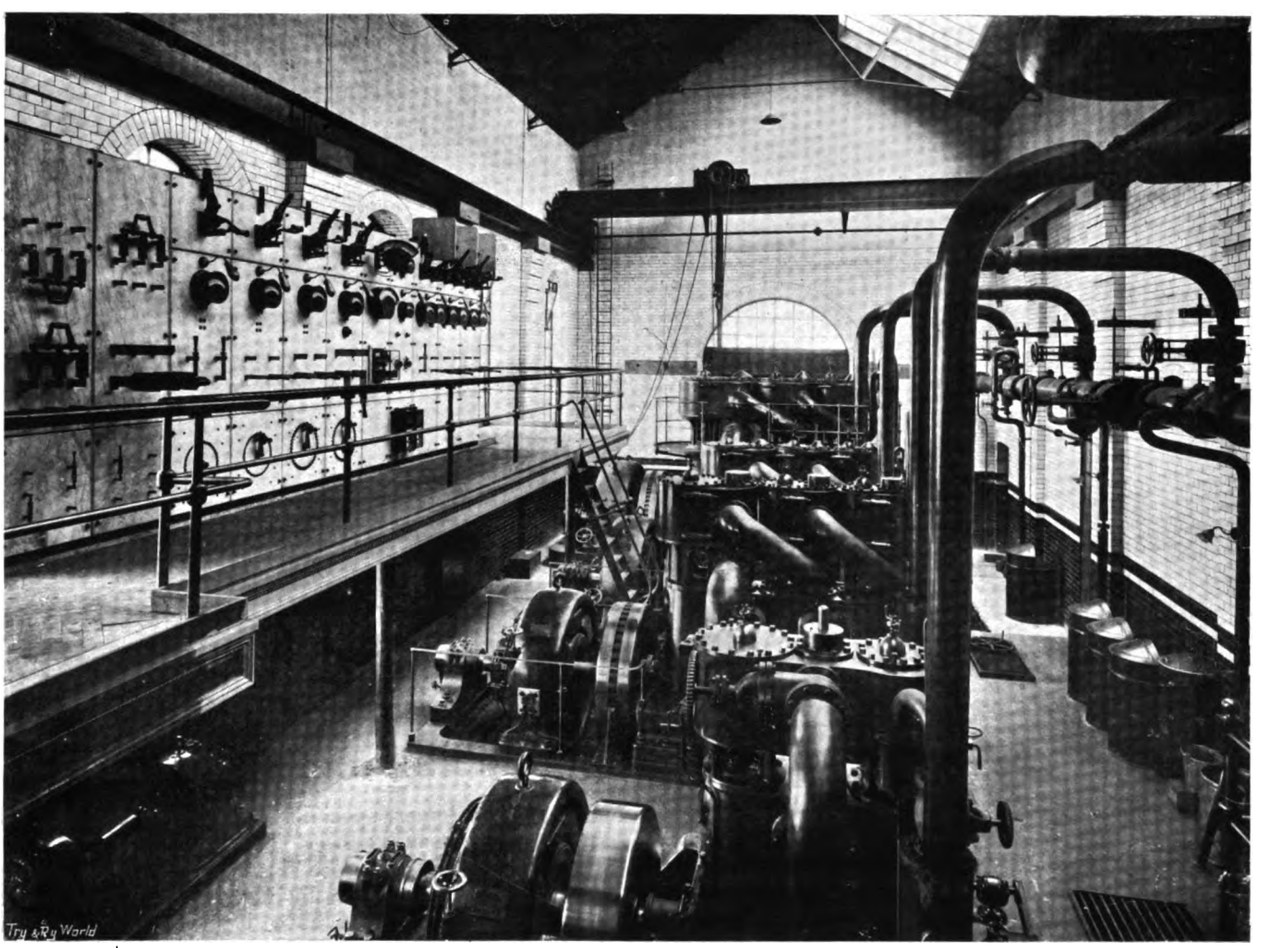
Of the five engines at present installed, four can be used either for the traction or lighting load, one being for lighting only. They are all Westinghouse-Belliss setts, and run at 300 to 420 revolutions per minute. The engines have a total output of 1,500 I.H.P., the last and largest machine having a capacity of 600 H.P., the others being 150 and 300 H.P. A hand crane of 10 tons capacity and 28 ft. span runs the length of the engine-room.

The generators are of the six-pole type, having a total output of 480 to 550 volts, and from 200 to 800 amperes, or a total of 1,000 KW.

Both lighting and traction switchboards are of the Westinghouse manufacture, and are conveniently arranged in two galleries, one at the end of the station and the other on the right. They are easily reached by an iron stairway, and are so placed as to have ample space behind.

A chloride battery of 280 cells, and rated at 600 ampere hours, is used for lighting only.

The rolling stock consists of 12 double-deck single truck cars made by the Brush Electrical Engineering Company. These cars are mounted upon Conaty radial trucks with a wheel-base of 8 ft. 6 in., and a spring-base of 16 ft. The wheels are steel tyred, and were supplied by Hadfield's Steel Foundry Company. The cars have a total seating capacity of 56, the inside seats numbering 34, and those on the top deck 22. The cars are all fitted with the usual hand brakes, but in addition they have been provided with the Westinghouse magnetic track brake—a precaution that immensely increases the safety of the cars and, at the same time, much diminishes the work of the drivers, who have quite enough to do in managing heavy electric cars and looking out for passengers, without the constant and more or less irritating labour of constantly winding the brake spindle. The rest of the car equipment is of the standard Westinghouse type, including two 25 H.P. motors and controllers and the usual accessories. The trolleys are of the Wood type. Life-guards have been supplied by Messrs. Hudson and Bowring, of Manchester.



Interior of Engine Room—Chesterfield Electricity Works.

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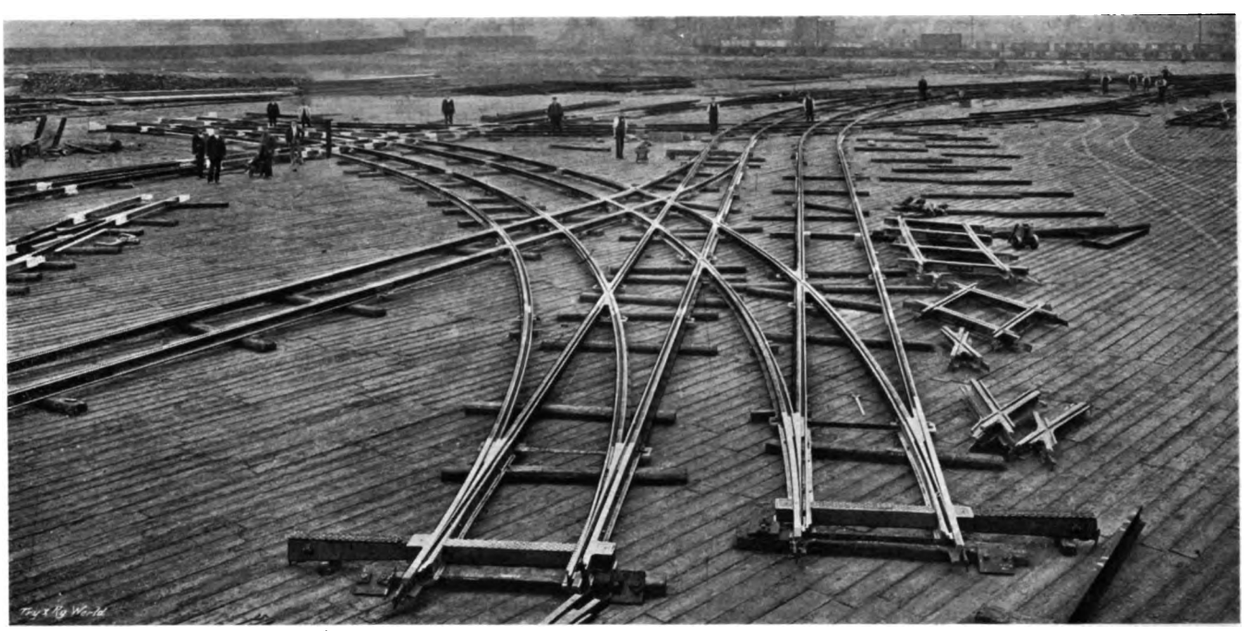
Ordinary service begins at 7 a.m. and finishes at 11-20 p.m. The average frequency of service is between seven and eight minutes, which increases to five minutes in the busy hours. Fixed stopping places, at intervals of about 200 yards, are indicated by specially painted poles. Fares range from 1d. to 3d., the latter being the through fare on the longest route of 3·5 miles.

Since the tramways have been opened the Town Council have appointed Mr. Acland to be general manager of the undertaking, and in recognition of the value of his services in acting as sole engineer during the equipment of the tramways, they have granted him a substantial increase in salary. Mr. G. B. K. Ingham will assist Mr. Acland as traffic manager. Mr. E. Shentall has been chairman of the Tramways Committee during the past four months, having succeeded Mr. F. Pearson, who was chairman when the decision to convert the tramways to electric traction was taken. It is gratifying to be able to add that the service since the opening of the lines has been thoroughly satisfactory both to the Council and the public. The undertaking has already justified itself as a great boon to the town, and it affords another illustration—if one were needed—of the great advantage to even a small town of modern methods of communication.

ABERDEEN HARBOUR DOCK RAILWAYS.

Some time ago the Aberdeen Harbour Commissioners decided to erect a new swing bridge to connect the Regent and Provost Blaikie's Quays, and to re-model the dock lines to meet present requirements. Mr. R. Gordon Nicol, the engineer to the Harbour Commissioners, was not satisfied with the type of rails, points, and crossings usually adopted for this class of work. His idea was that a much heavier section, and of the grooved type usually adopted for electric tramways, was the best rail for the purpose, but unfortunately the rail makers at that time were unable to supply the heavy grooved section he required, and he eventually adopted the heavy T rail, of which we show a section. The rails weigh 111 lb. per yard, and have riveted to them a check rail of special section weighing 46 lb. per yard. All the rivet holes were drilled to template, and $\frac{7}{8}$ in. diameter rivets were used throughout the work. The width of the groove is $1\frac{3}{4}$ in., but on curves it is increased to 2 in. The rails are in 30 ft. lengths, with lap or staggered joints, which allowed the guard rail to form the fish plate on the check side. The fish plates are 18 in. long, with four holes for 1 in. diameter bolts.

The usual railway clearance of $\frac{1}{4}$ in. is allowed at all joints, but a special feature of the joints is the adoption, for the first time on dock railways, of special sole plates and clips. These are securely fixed to the rails and sleepers by means of $\frac{7}{8}$ in. bolts and nuts, and by this means the rails are kept in position and to gauge. All the track is laid on wooden sleepers, well ballasted in, and afterwards paved in with Aberdeen granite setts. A good deal of attention has been given to the drainage of the track, and at regular intervals Hadfield's patent drain boxes, specially designed to suit the rail section, have been fixed.



Special Track Work for Aberdeen Harbour Dock Railways on Lay-out Floor at Hadfield's Steel Foundry.

An interesting departure from ordinary dock railway practice is the adoption by Mr. Nicol of cast points and crossings. These have been supplied by the Hadfield's Steel Foundry Company, of Sheffield, and are made in their patent "Era" manganese steel. The points are 13 ft. long, of 160 ft. radius, and the tongues have been specially designed to suit the heavy working conditions. The tongues are connected by rods and levers, the actuating mechanism being contained in a box at the side of the points. The throw-over levers are detachable, and are carried by the shunters.

At the north and south end of Regent Bridge special points with double radii are provided to divert the traffic to the right or left as required. With this design of points and crossings a much neater and more permanent job can be made of the surrounding pavement, while by having them in "Era" manganese steel Mr. Nichol has adopted the most durable material for the purpose.

In addition to supplying the points and crossings, the Hadfield's Steel Foundry Company also constructed

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the lines, and these were originally laid out in sections at their works. Some idea of the extent and intricate nature of this portion of the work will be obtained from the accompanying photograph of the south junction on the lay-out floor at Hadfield's works when almost ready for the engineer's inspection. The length of this junction is nearly 500 ft., and in addition to the large number of curved rails, it comprises 15 pairs of points and no less than 76 crossings. The total weight of material in this junction alone is 160 tons, and in accordance with Mr. Nichol's specification all the rails were curved in the firm's special power bending press.

In connection with the opening ceremony of the Regent Bridge, the dock locomotives with long trains of heavily laden wagons ran over the lines at a rate of 10 to 12 miles an hour, passed smoothly round the curves, and travelled over the points and crossings without a hitch. This was witnessed by harbour and dock engineers from all parts of the country, and could not fail to impress them with the accuracy and stability of the work. At the north and south end of the bridge making up pieces made of "Era" manganese steel were supplied. These pieces are chequered to correspond with the cast iron curbs, and are securely bolted to the latter, and are fished to the points by standard fish plates.

VOLTAGE REGULATORS FOR GENERATORS.

The necessity of maintaining as constant as possible the voltage of generators, whether of alternating or continuous currents, is everywhere recognised, and the regulation of the voltage of alternators is specially important. When the current is used for lighting, small changes in pressure are more to be guarded against even than in traction work. If the voltage can be maintained at normal, the life of the lamps and the proportionate candle-power alike reach the maximum. It is found, for example, that should the voltage be increased 1 per cent. above normal, the life of the lamp would be reduced 20 per cent., while the candle-power would be increased only 6 per cent. above normal. Should the pressure go to 5 per cent. above the standard, the life of the lamp would be reduced 64 per cent., while the candle-power would be raised only 33 per cent. On the other hand, if the voltage were reduced 2 per cent. below normal the life of the lamp would be increased 50 per cent. above normal, while the candle-power would be decreased 11 per cent.

In view of these facts the British Thomson-Houston Company have developed and are now placing on the market regulators for automatically keeping the voltage constant, independently of speed changes and variations in load. These are mounted on a marble or slate base for attachment to the switchboard, and the device is enclosed in a glass case which can be opened for inspection. They are made in two forms, type T A for alternating-current generators, and type T D for continuous-current machines.

Figs. 1 and 2 are front and back views of the former type. The voltage is automatically maintained at any

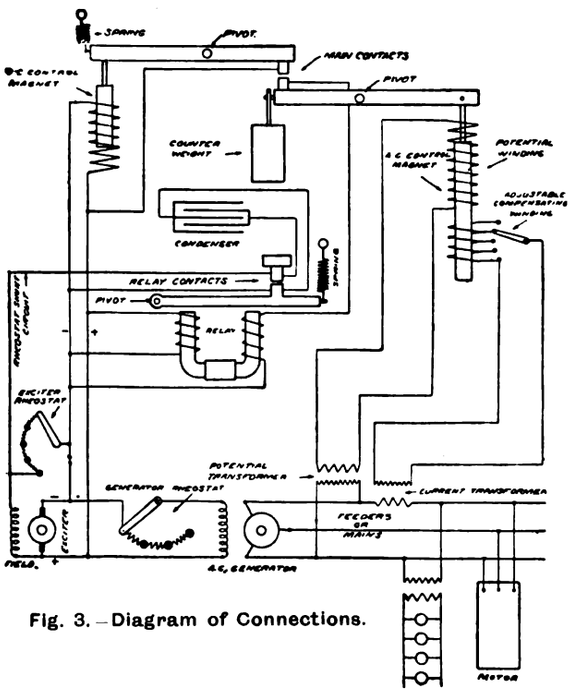

Fig. 3.—Diagram of Connections.

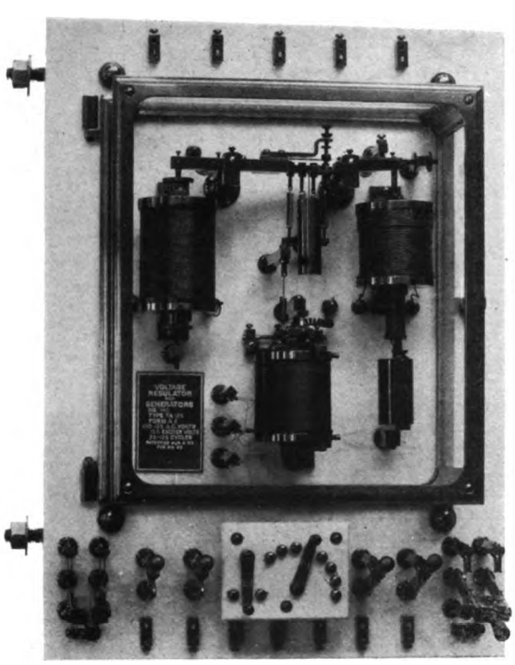

Fig. 1.—Front View of Regulator.

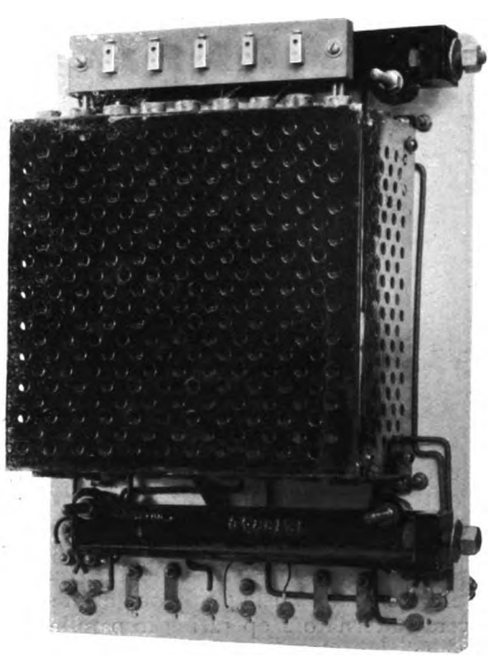

Fig. 2.—Back View of Regulator.

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desired value by varying the exciter voltage by means of the regulator. This is accomplished by rapidly opening and closing a shunt circuit across the exciter field rheostat. The moving parts of the regulator are all very light and move only a short distance; thus they can operate at a high rate of speed without any pumping or hunting effects often found in other forms of regulator. Fig. 3 shows the elementary connections. The rheostat shunt circuit is opened and closed by a differentially wound relay. The current for operating this relay is taken from the exciters busbars, and is controlled by floating main contacts. The current for energising a continuous-current control magnet is taken from the same bus. The relay and the continuous-current control magnet constitute the continuous-current portion of the regulator, and maintain not a constant but a steady exciter voltage. The alternating current portion of the regulator consists of a magnet having a potential winding connected by means of a potential transformer to the busbars or the circuit to be regulated. This magnet also has an adjustable compensating winding which is connected in series with the secondary of a current transformer in the principal lighting circuit. The core of this magnet is attached to a pivoted lever carrying a counterweight, which is balanced by the attraction of the magnet. If a load is thrown on the generator, the voltage will tend to drop, the alternating-current magnet will weaken and destroy the balance of the core and lever, and cause the main contacts to close. This in turn will close the relay contacts and entirely short-circuit the exciter field rheostat, thus increasing the exciter voltage until the original balance of the alternating-current magnet core and lever is restored, and the alternating-current voltage maintained at the required value. Figs. 4 and 5 are from charts of recording instruments, showing how the regulator steadies the voltage.

The instrument is also used with suitable connections with several generators using only one exciter, and also with several alternators operating in parallel. In this case an equalising rheostat is necessary to equalise the load between the exciters.

The regulator for continuous-current machines works on the same principle as the other, but is simplified by the fact that the exciting voltage is the same as the voltage to be regulated. It is therefore possible to dispense with one operating coil. These instruments will regulate shunt or compound-wound generators, but in use with the latter the regulator must be arranged to regulate only one generator at a time. All the generators operating in parallel should be connected to the regulator so that regulation may be obtained from any one of the generators, or when only one is operating at a time. To enable this to be done, each regulator is provided with a five-point rotary switch.

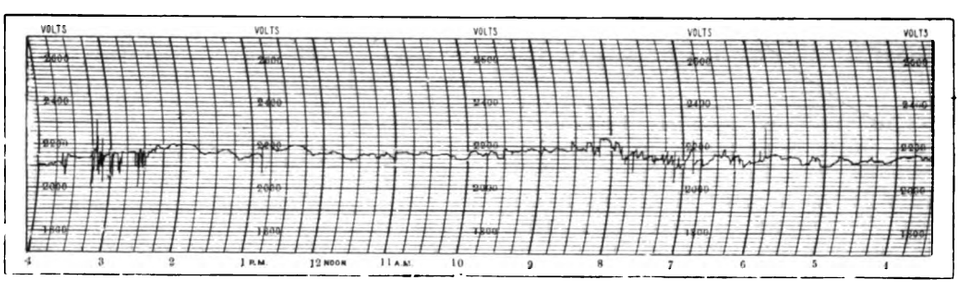

Fig. 4.—Variations of Voltage without the Regulator.

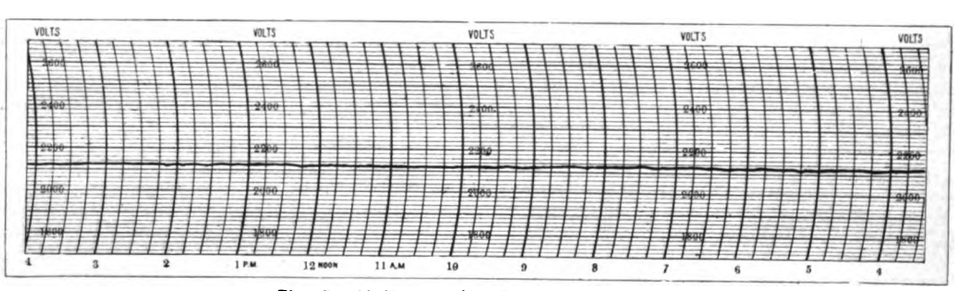

Fig. 5.—Voltage with Regulator in use.

THE BIRMINGHAM TRAMWAY SCHEME.

The accompanying map shows the Birmingham tramway system as it will be, should all the lines proposed by the bill to be promoted by the Corporation in the coming session of Parliament be sanctioned. The total length of the new lines is 33 miles measured as single track, and the whole scheme has been approved by the Corporation on the recommendation of the Tramways Committee, based upon the proposals formulated by the general manager, Mr. Alfred Baker.

The cost of the construction of the new tramways, including street widening, re-construction of existing tramways, overhead electrical work, car sheds, rolling stock, etc., is estimated at £1,018,350, made up as follows:

	£	s.	d.
(a) Cost of constructing the new tramways, excluding electrical equipment	295,530	0	0
(b) Cost of electrical equipment of new tramways and of reconstruction and electrical equipment of such of the existing tramways, the leases of which expire in 1906, as have not yet been reconstructed, viz.:			
Track work, electrical equipment and street works .. (£ 235,000 s. 0 d. 0)			
Land, car sheds, workshops, and machinery .. .. (£ 135,620 s. 0 d. 0)			
Rolling stock .. .. (£ 184,200 s. 0 d. 0)	554,820	0	0
(c) Street widenings: Purchase of properties and street works in connection with widenings ..	168,000	0	0
	£1,018,350	0	0

It is intended to apportion the cost of the street widenings between the Public Works and Tramways Committees, having regard to the extent to which such widenings are required as street improvements or for tramway purposes. The estimates do not include anything for a power-station, the cost of which is provided for by the electricity department.

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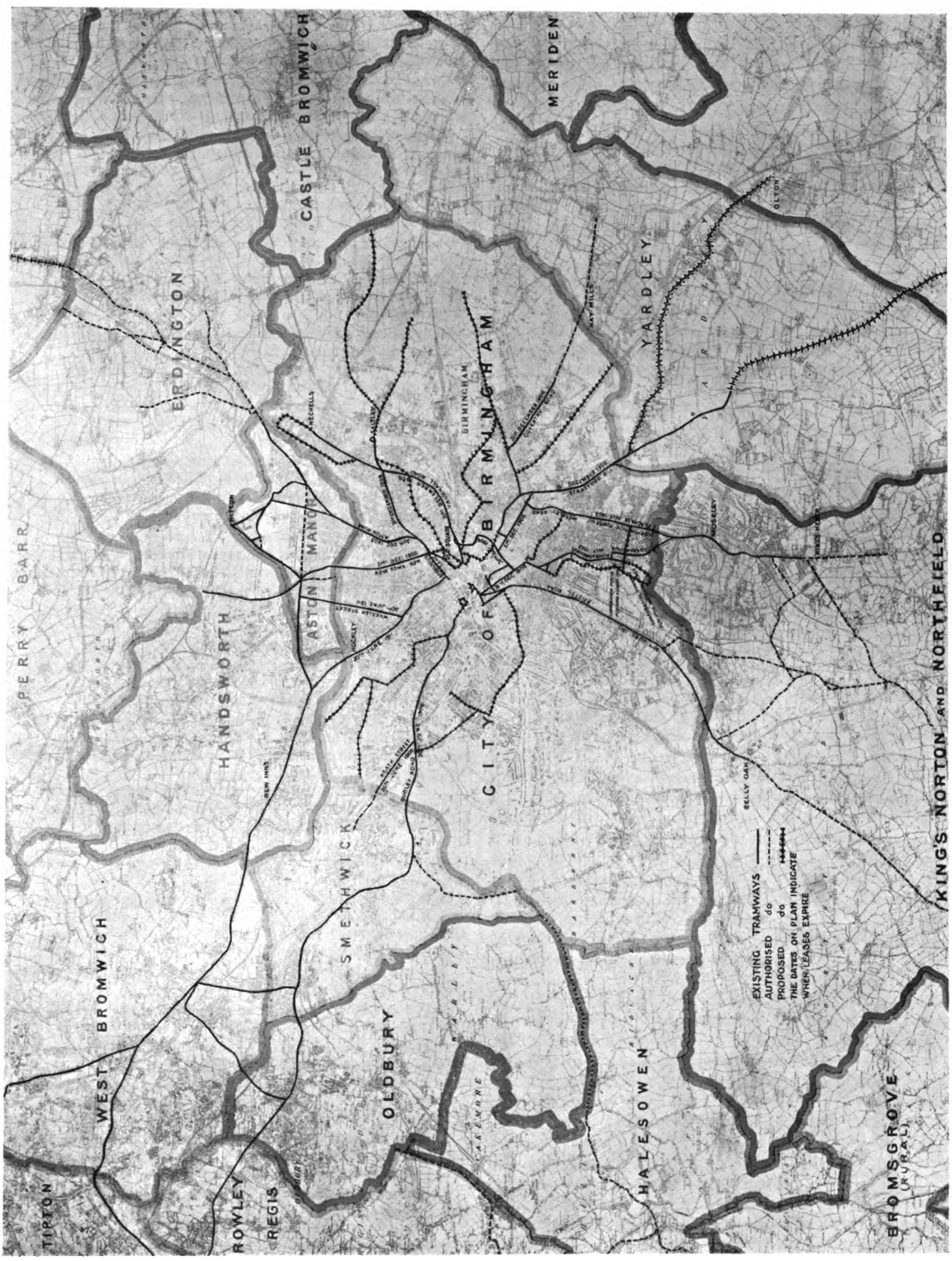

Map of Birmingham Corporation Tramways.

Showing the Existing Lines, the Authorised Lines, and the Extensions for which Parliamentary Sanction will be sought in the next Session.

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TRAMWAY AND ELECTRIC RAILWAY LEGISLATION.

SESSION OF 1905.

In our issue of December 8 last appeared a list of tramway and electric railway bills to be promoted in the coming session of Parliament, and we now give our usual tables showing the lengths of new line proposed, the estimated cost, and the capital powers sought. In the accompanying notes some points are mentioned which could not be included in the objects of the bills published in December.

The two main features are the revival of London tube railway schemes, and the general collapse of tramway promotion, especially by companies. Capital for tramways appears to be hard to get, and the restrictions on companies by the general law and by local authorities, tell their own tale. A great many of the bills promoted do not propose new lines, but seek extensions of time, financial rearrangements, and so forth. But for the London railway schemes and the tramway proposals of Birmingham and Glasgow, the tables would present a still more forlorn aspect. Last year there were no proposals for new tube railways in London, owing to the sitting of the Royal Commission, and those now brought forward are revivals of previous years' bills. Whether they will be allowed to proceed remains to be seen.

The tables call for no further remark except that a comparison may be made with last year. At that time there were a few minor measures connected with London railways, but they did not propose new lines. They however, contained powers for a little additional capital. The total number of electric railway and tramway bills of all sorts brought forward by companies was 33, with 118¾ miles of double track and 62¾ miles of single. The estimated cost was £4,075,533, and the capital was £5,574,666. This year there are 35 such bills, proposing 63 miles of double track and 13 miles of single. The estimated cost is £17,829,639, and the capital £26,114,000. Practically the whole of these totals, however, is for London railway bills, companies' tramway proposals being almost negligible. As to local authorities' bills, last year there were 23, representing 92¾ miles of double track and 29 miles of single, with an estimated cost of £5,310,767, and borrowing powers of £5,375,536. This year there are only 13 local authorities' bills, representing 43¾ miles of double track and 22¾ miles of single. The estimated cost is £2,152,415, and the borrowing powers £2,854,853. Never since electric tramways really got a foothold in this country has there been so poor a record.

Fifty-one bills were mentioned in our December issue, but that number has now been reduced to 48, as it appears from the Cork Junction Railways Bill that the promise that powers should be sought to work the lines electrically has not been carried out, and as the Liverpool and Bury Tramway Bills have been dropped, the former because of an adverse vote of the ratepayers, and the latter because there was not a sufficient majority for the bill at a confirming meeting of the Town Council. As on former occasions, the estimates of expense in the case of companies do not include electrical equipment, while the municipal estimates do.

NOTES.

LONDON ELECTRIC RAILWAY BILLS (TABLE I.).

BAKER STREET AND WATERLOO RAILWAY.—The estimate is for four subways for foot passengers. Some of them are in substitution for authorised subways, the construction of which is to be abandoned.

EDGWARE AND HAMPSTEAD RAILWAY.—The net additional cost under this bill is only £632. The figure in the table is the estimated cost of the deviation railway proposed by the bill, but the authorised piece of railway which is in consequence not to be constructed, was estimated to cost £25,080.

GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY (No. 1).—The proposed extension of the Strand spur of this railway to Waterloo is to be single track. As the distance is short, one shuttlecock train could give a very frequent service. Other parts of the single track length are short junction lines at Holborn, and form really double track railways with some space between the separate tunnels. Some of them are in substitution for authorised junction lines, the construction of which it is proposed to abandon.

GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY (No. 2).—The single track lines form practically double track railways, but the up and down tracks and tunnels follow slightly different courses.

GREAT WESTERN RAILWAY (NEW RAILWAYS).—Among the lines proposed in this bill is one from Ealing to Shepherd's Bush, and it only is included in the table. It may be expected to be an electric railway as soon as the other Great Western Suburban lines are electrified. The estimated cost given is for this railway alone, and the capital required for it is taken on a similar basis.

HAMMERSMITH, CITY, AND NORTH EAST LONDON RAILWAY.—Out of the total length, 6 miles 18 chains will not be in tunnel. The estimate includes sums for street widenings and lands, and £400,000 and £150,000 for power-stations at Hammersmith and Shoreditch respectively.

NORTH EAST LONDON RAILWAY.—Out of the total length, 13 miles 8 chains will not be in tunnel.

OTHER COMPANIES' BILLS (TABLE II.).

GREAT WESTERN RAILWAY (ADDITIONAL POWERS).—The only part of this bill in which readers are directly interested is that providing for the company running motor omnibuses.

LONDON SOUTHERN TRAMWAYS COMPANY.—It is sought to provide that the powers of the London County Council to purchase the lines (which it is proposed to electrify) shall not be exercisable for 42 years.

NORTH EASTERN RAILWAY.—The part of this bill of direct interest is that seeking power to run motor omnibuses.

PAISLEY DISTRICT TRAMWAYS.—It is proposed that the period before which the tramways cannot be purchased by the local authorities should be extended to 40 years. The bill also provides that it shall not be necessary for the cars to be licensed as hackney carriages.

SOUTH EASTERN AND LONDON, CHATHAM, AND DOVER RAILWAY.—The point in this measure is the transfer to the company of the Sheppey Light Railway at a purchase price of £65,000.

SOUTHEND AND COLCHESTER LIGHT RAILWAYS.—The estimate is for the construction of piers which are to be used in conjunction with the railways and with ferries proposed to be established.

WEMYSS TRAMWAYS.—This bill is brought forward in name of a single promoter, Mr. R. G. E. Wemyss, so that there is no statement of capital. Part of the route will be tramroad on lands belonging to the promoter.

LOCAL AUTHORITIES' BILLS (TABLE III.).

ABERDARE TRAMWAYS.—The estimate includes £12,396 for new streets and widenings, and £14,300 for generating station and refuse destructor.

ACCRINGTON CORPORATION.—£7,000 for street works is included in the estimate.

BIRMINGHAM CORPORATION.—The estimate is made up of: Tramway construction, £295,530; reconstruction of existing tramways, electric equipment of tramways, land for generating station, depôts, etc., £554,820; street works, £202,200.

BLACKPOOL IMPROVEMENT.—The £13,000 of borrowing powers is for a road improvement.

CROYDON CORPORATION.—The estimate includes £12,000 for omnibuses and £25,000 for street widenings.

GLASGOW CORPORATION (TRAMWAYS CONSOLIDATION).—This is a further powers as well as a consolidation bill. The borrowing powers mentioned in the measure are £3,200,000, but as the existing borrowing powers are over two millions, the new powers are entered in the table at a million.

LONDON COUNTY COUNCIL (TRAMWAYS).—The estimate includes the cost (£26,000) of the proposed deviation of the southern end of the Embankment—Southampton Row subway.

NOTTINGHAM CORPORATION.—£38,700 is included in the estimate for street improvements.

ERITH'S ENGINEERING COMPANY, of 70, Gracechurch Street, E.C., have issued two useful catalogues descriptive of their patent underfeed stokers. "Smoke Prevention effected by Economical Combustion" is the title of a pamphlet which deals exhaustively with the subject of fuel economy, and a comparison of the various systems in vogue is made in order to show that Erith's patent underfeed stoker gives the most satisfactory results. The catalogue of underfeed stokers illustrates the application of this principle to municipal electricity works, railway workshops, engineering and chemical works, etc.

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Table I.—London Electric Railway Bills.*

Name of Bill.	Length in Miles and Chains. Double Track.	Single Track.	Total—Reckoned as Single Tr. ck.	Estimated Cost.	Capital.
	M. Ch.	M. Ch.	M. Ch.	£	£
Baker Street and Waterloo Railway	—	—	—	42,500	—
Central London Railway (New Lines)	8 37	0 20	17 14	3,223,478	4,200,000
Edgware and Hampstead Railway	0 35	-	0 70	25,712	—
Great Northern, Piccadilly, and Brompton Railway (No. 1)	0 11	1 30	1 52	498,521	600,000
Great Northern, Piccadilly, and Brompton Railway (No. 2)	8 49	0 78	18 16	3,709,110	5,600,000
Great Western Railway (New Railways)	4 38	—	8 76	429,156	430,000
Hammersmith, City, and North East London Railway	19 33	0 27	39 13	6,950,627	9,600,000
Metropolitan Railway	—	—	—	—	1,066,000
North East London Railway	17 19	—	34 38	2,692,405	4,000,000
Whitechapel and Bow Railway	—	—	—		200,000
Totals	58 62	2 75	120 39	17,571,509	25,696,000

* The following are additional bills, which do not propose any new lines or fresh capital powers:

Charing Cross, Euston, and Hampstead Railway. Metropolitan District Railway.

Table II.—Other Companies' Bills.*

Name of Bill.	Length in Miles and Chains. Double Track.	Single Track.	Total—Reckoned as Single Track.	Estimated Cost.	Capital.
	M. Ch.	M. Ch.	M. Ch.	£	£
Gosport and Fareham Tramways	0 47	0 57	1 71	15,608	—
Hastings Tramways	1 44	—	3 8	9,418	—
London Southern Tramways Company	—	—	—	8,717	180,000
Metropolitan Electric Tramways	—	—	—	63,000	—
Oldham and Saddleworth District Tramways	0 5	0 58	0 68	8,897	20,000
Paisley District Tramways	0 56	2 43	3 75	30,077	66,000
Southend and Colchester Light Railways	-	—	—	70,000	152,000
Wellingborough and District Tramroads and Electricity Supply	—	0 7	0 7	922	—
Wemyss Tramways	1 28	6 69	9 45	51,491	—
Totals	4 20	10 74	19 34	258,130	418,000

* The following other bills do not propose any new lines nor fresh capital powers in the way of electric traction:

Blackpool, St. Anne's, and Lytham Tramways.
Buenos Grand National Tramways Company, Limited.
Coventry Electric Tramways (Extension of Time).
Dublin United Tramways.
Great Western Railway (Additional Powers).
London United Tramways.
Metropolitan and Great Central Railway Companies.
Mexborough and Swinton Tramways.
North Eastern Railway.
South Eastern, and London, Chatham, and Dover Railway.
South Lancashire Tramways.
Tyneside Tramways and Tramroads Company.
Ulster and Connaught Light Railways.
West Cumberland Electric Tramways.

Table III.—Local Authorities' Bills.*

Name of Bill.	Length in Miles and Chains. Double Track.	Single Track.	Total Reckoned as Sing'e Track.	Estimated Cost.	Borrowing Powers.
	M. Ch.	M. Ch.	M. Ch.	£	£
Aberdare Tramways	0 40	4 25	5 25	93,576	93,576
Accrington Corporation	0 40	1 44	2 44	126,615	126,615
Birmingham Corporation	12 77	7 6	33 0	1,052,550	1,054,000
Blackpool Improvement	0 35	—	0 70	19,171	13,000
Croydon Corporation	3 8	2 37	8 53	170,142	170,142
Glasgow Corporation (Tramways Consolidation)	20 42	0 22	41 26	292,841	1,000,000
Halifax Corporation	0 75	5 61	7 51	57,820	57,820
London County Council (Tramways)	2 47	—	5 14	209,000	209,000
Nottingham Corporation	1 67	0 14	3 68	95,700	95,700
Wigan Corporation	0 34	1 18	2 6	35,000	35,000
Totals	43 65	22 67	110 37	2,152,415	2,854,853

* The following bills do not propose any new lines nor fresh borrowing powers:

Bromley Corporation. Rhondda Urban District Council. Swansea Corporation.

Table IV.—Totals.

	Length in Miles and Chains. Double Track.	Single Track.	Total—Reckoned as Single Track.	Estimated Cost.	Capital or Borrowing Powers.
	M. Ch.	M. Ch.	M. Ch.	£	£
London Electric Railway Bills	58 62	2 75	120 39	17,571,509	25,696,000
Other Companies' Bills	4 20	10 74	19 34	258,130	418,000
Local Authorities' Bills	43 65	22 67	110 37	2,152,415	2,854,853
Grand Totals	106 67	36 56	250 30	19,982,054	28,968,853

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LONDON ELECTRIC RAILWAYS.

At a meeting of the Society of Arts, in London, on January 25, Mr. Robert P. Porter read a paper on London electric railways.

Lord GEORGE HAMILTON, M.P., who presided, made some interesting introductory remarks. He said that he had had special, almost unique, opportunities of seeing the marvellous augmentation of the population of Inner and Greater London. Thirty-eight years ago he was elected member of Parliament for the whole county of Middlesex, which comprised all the outer area north of the Thames. The population he represented when he first entered Parliament was two hundred thousand; now the population of the same district was more than a million. Suburban London had its occupation in the City, and it was this feature which caused the great difficulty of locomotion in the Metropolis. In Inner London it was impossible to increase the facilities offered on the surface. Streets were not built in accordance with any great plan; they were the streets of a number of original hamlets or villages which had been absorbed in London; it was impossible to have any great system of thoroughfares such as many other capitals had. Sir Edmund Henderson, who was Chief Commissioner of Police, had said "The streets of London were intended for the traffic of five hundred thousand, and I have to manage the traffic of five milllons." But for the tact, patience, and skill of the police who managed the traffic in London it would be very difficult to get about the streets. To deal with the traffic problem recourse would have to be had to underground railroads of such a character as not to interfere with the stability of houses. If these railways solved that problem those who achieved the object would confer a great benefaction on London generally.

Mr. R. P. PORTER, in his paper, first contended that the problem of how to relieve the congested streets of London could only be successfully worked out by methods in harmony with existing conditions, and not by grafting methods which had been developed under entirely different conditions elsewhere. He glanced at the conditions in various cities, pointing to the different ways in which town districts were situated and laid out, to geological formation, and to municipal and military considerations. In all the great cities underground railways and other means of rapid transit incubated slowly. The London Inner Circle Railway was for its time a monumental work of engineering enterprise. In this, as in so many other branches of constructive engineering work, England showed the way for other countries to follow. The first tubular railway was also a purely British idea, and first put to practical use in London. The Act sanctioning the City and South London Railway was only passed after great opposition. Turning to other cities, Mr. Porter described the recent and rapid development of underground electric railways in Chicago for carrying freight. There were now 30 miles of these tunnels completed, and the Illinois Tunnel Company expected shortly to be able to deliver 50,000 tons of freight per day. The tunnels had walls of concrete, and were of horseshoe shape. They were of two sizes—trunk conduits 12 ft. 9 in. wide and 14 ft. 6in. high, and lateral conduits 6 ft. wide and 7 ft. 6 in. high. The roofs of the tunnels were not allowed to come closer than 24 ft. 6 in. from the surface of the street. The cars used were each capable of carrying 7 tons of coal or 24 barrels of flour. By this system the procedure in London, New York, and elsewhere was reversed, as instead of putting the people into underground railways and leaving freight traffic on the streets, the streets were to be left free for the public and relieved of an enormous amount of goods and coal traffic, which would be carried by the underground railways. All the principal buildings in the business centre were connected with the tunnels, and received and despatched goods, etc., direct. Passing to New York, Mr. Porter described the new Subway system, and said that the whole thing worked as smoothly as if it had been going on for a number of years. Having touched on the probable early extensions of the Subway, he referred to the Pennsylvania Railroad underground extension through the heart of New York, which he said would cost about ten millions sterling. Reference was next made to the electrification of the New York Central Railway lines and to the new harbour tunnel at Boston, and Mr. Porter explained that the ordinary street cars ran through this tunnel, the overhead trolley system being employed throughout. He subsequently described generally the Paris Metropolitan Railway and the Berlin Elevated and Underground Railway.

Returning to the subject of London, Mr. Porter gave the following comparative figures as to population and route length of railways within what is now the county of London at the dates specified:

Year.	Population.	Miles of railway.
1845	1,949,277	29¾
1860	2,808,404	69¼
1880	3,830,297	215¼
1900	4,536,541	248½

The track mileage had increased much more rapidly, as additional tracks had been laid down on many lines. He elucidated the growth by a series of maps, and deduced from his consideration of the subject that the only possibility left for railway extension in London was underground. London was essentially a railway, not a tramway city. There were in London and extra-London 531 railway stations, and with the opening of the new tube railways this number would be increased to over 600. The length of lines, including tube railways, in Greater London was over 630 miles. Of the stations, 22 were termini, and into them poured daily 4,252 suburban trains and 445 other trains. The same number must go out. The difficulty of getting passengers from the termini to their business would be remedied in large measure by the new tubes. Electrification of local lines and separation from trunk line traffic would increase carrying capacity and reduce expenses. Four-fifths of the half million of passengers brought into the central area of London every morning were conveyed by railways, and one-fifth by tramways. Statistics were given of the numbers of railway passengers, and Mr. Porter said that the new tubes and the electrified District and Metropolitan Railways would provide for carrying an additional 400 to 450 millions of passengers per annum. He thought that the new accommodation would be absorbed as soon as it was ready for use. He next referred to the electrical installations for the Metropolitan and District Railway, and passed on to describe the routes of and traffic dealt with by existing tube railways, and to discuss the questions of ventilation and protection against fire. In regard to the tube railways now under construction, Mr. Porter outlined their routes and showed how they would facilitate transit by interchange stations at numerous points. On the question whether the new tube railways would pay, he thought they would, and with the growth of London they would undoubtedly become profitable investments. Reviewing his subject generally, Mr. Porter said that he was no advocate of transportation by underground electric railways alone, as all methods had their place in the solution of the London problem. The important thing was to get all the means of communication to work in harmony. The unification of the several facilities by some common ownership or consolidation of management must be precedent to any really satisfactory or lasting solution of the problem. It was large electrical power-houses that would bring the interests together. The tangle of steam railways in London would, he believed, be electrified within ten years and operated on some harmonious system. Another movement working for the relief of the streets was the change of the omnibus and car companies from horses to motors. In the aggregate the work going forward at the present time was enormous, and exceeded in mileage and capital investment the great works in Paris, New York, and Chicago. As a rule most of the modern towns of the world were fairly well supplied with rapid transit, and in those cities the problem did not present anything like the difficulties and obstacles which had to be overcome when dealing with this question in the greatest of all modern centres of population—London.

LONDON COUNTY COUNCIL TRAMWAY MATTERS.

The London County Council resumed its sittings after the Christmas recess on January 24.

TRAMWAY TRAFFIC DURING FOG.

In the report of the Highways Committee, it was stated that the exceptionally foggy weather which prevailed during the week preceding Christmas necessitated the cessation or dislocation of a very large proportion of ordinary traffic in London, but the Committee reported with much satisfaction that the Council's tramways staff performed their duties so assiduously that the car services were well maintained. The Committee had arranged for the whole of the staff to be informed of the high appreciation of the energetic manner in which the employees had carried out their specially arduous duties.

END SCREEN FOR GREENWICH STATION.

The Committee reported that, in accordance with authority given to them, they had, during the Christmas vacation, opened tenders for the erection of the temporary end screen required for the first portion of the Greenwich generating station. The tenders received were;

Wm. Harbrow, London ...	£1,437	H. Lovatt, Limited, London	£1,880
J. McManus, London ...	1,876	Humphreys, Limited, London	2,441

They had decided that the lowest tender, that of Messrs. Harbrow, was satisfactory, and they accepted it.

THE NORTHERN TRAMWAYS.

The report also made reference to the consideration, by various bodies concerned, of the drawings showing the proposed conduit system for the first sections of the northern tramways to be electrified, and the Committee reported that the Board of Trade had now signified their approval of the system, and of a slot not exceeding one inch in width.

MISCELLANEOUS.

In a report presented by the Establishment Committee, it was recommended that an advertisement be issued inviting applications for the vacant post of principal assistant in the engineer's department of the Council at a salary of £500 a year. They also proposed that a resolution passed on December 13 last, authorising an advertisement for applications for the position of assistant in the mechanical section of

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the engineer's department, be rescinded, as the engineer had now asked that the filling of the vacancy should be postponed for a few months.

The same Committee proposed that an agreement be entered into with Messrs. Mann and Overton, 7a, Lower Belgrave Street, S.W., for the hire for six months of two motor cars for £800, for the use of committees and heads of departments. Seven offers had been received, and the Committee considered that the one recommended was the most satisfactory.

The Highways Committee recommended approval of an expenditure of £5,000, in addition to that of £24,364 already authorised, for laying of cable ducts for the New Cross and Greenwich sections of the tramways, under the contract with Messrs. Reid Brothers. Several reasons were assigned for the excess expenditure, among them being that in some places it had been found necessary to lay the ducts in the carriage way, thus increasing the cost, and that underground obstructions proved to be very numerous.

The various proposals were adopted by the Council.

Mr. PHILLIMORE asked where the superiority of the tramcars lay in foggy weather.

Mr. BAKER (chairman of the Committee) replied that the advantage lay in the fixed lines. The men had rendered splendid service during the foggy weather.

Mr. GILBERT said that during the fog people had to abandon the trains, and the only means of getting near their homes was by the Council's cars. He testified to the pluck and skill of the motor-men, and said that many people wished that the services so rendered could have been recognised in a more tangible way than by a formal expression of thanks.

Mr. HUBBARD said he wished the heat underneath the seats could be removed. This made the cars most unpleasant sometimes.

Mr. YATES asked what the extra profit was on the covered cars.

Mr. BAKER, in reply, said that the extra profit was about 1½d. per car-mile on the covered cars, or about £4 a week per car. The covered cars were very popular. As to the heat underneath the seats, this was caused by the electrical arrangements on a few of the cars, which were being altered, and he hoped the inconvenience would soon be done away with.

TRAMWAY INVENTION BY AN OFFICIAL.

At a meeting of the London County Council on January 31, a report was presented by the General Purposes Committee, which contained an illustration of the peculiar arrangements under which the employees of the Council have to work. The Committee stated that they had had before them an application by Mr. W. Watkins, an official in the engineer's department, asking that he might be allowed to take out a patent for a continuous feed system which he had invented for electric conduit tramways. The standing orders provided that any official who desired to take out a patent for an invention must, after obtaining provisional protection, obtain the permission of the Council before taking further steps, and the Committee now recommended that Mr. Watkins be permitted to take out his patent, subject to the condition that the Council be allowed to use it without payment.

NEW TRAMWAY CONSTRUCTION IN NORTH LONDON.

The Highways Committee, in their report, stated that they had considered six tenders which had been received for road work and plate-laying for the electric conduit tramways authorised by the Council's Act of 1904, from the existing lines in Clerkenwell Road, *via* Rosebery Avenue and St. John Street Road to the existing lines at the Angel, Islington. The following were the tenders:

John Mowlem and Company, Limited, London	£27,925 0 0
R. W. Blackwell and Company, Limited, London	29,149 14 6
William Griffiths and Company, Limited, London	29,704 1 5
Dick, Kerr and Company, Limited, London	29,924 9 10
J. G. White and Company, Limited, London	31,218 7 10
Muirhead, Greig, and Matthews, London...	31,619 15 6

The engineer's estimate of the cost was £26,432 16s. 5d. The Committee were of opinion that the lowest tender, that of J. Mowlem and Company, Limited, should be accepted. It was proposed that in the first instance the lines should be worked by horses, and that until electric traction was adopted the conductor rails should not be placed in the conduits. The tramways, when completed, would be worked by the North Metropolitan Tramways Company, in conjunction with the other northern lines. The Committee accordingly recommended that Messrs. Mowlem's tender be accepted, and that that firm be allowed to sublet the following portions of the work: (1) To the Hadfield Steel Foundry Company, Limited, of Sheffield, the manufacture of the special work (consisting of points, crossings, etc.); (2) to the Anderston Foundry Company, Limited, of Middlesbrough, the manufacture of cast-iron yokes, road boxes, and covers; (3) to the Associated Portland Cement Manufacturers, Limited, and Messrs. Martin, Earle, and Company, the supply of cement; and (4) to Messrs. Bayliss, Jones, and Bayliss, Limited, of Wolverhampton, the manufacture of the tie-bars and bolts.

The various proposals were adopted.

Mr. BAKER, replying to a question in reference to a statement made by Mr. Cosmo Bonsor at a recent meeting of the South Eastern Railway Company, said that so far from the tramways being aided from the rates, the tramways had aided the rates in the past six years by £293,592.

BRIGHTON RAILWAY ELECTRIFICATION.

Confirming the reports which have been current for some time, it was officially announced during January, on behalf of the London, Brighton, and South Coast Railway Company, that they are about to proceed to put to the test on a section of their line the single-phase alternating-current system of electric traction. Their consulting electrical engineer, Mr. Philip Dawson, has drawn up the scheme, which deals with the part of the railway between Battersea Park and Peckham Rye, a length of about five miles. This section has been selected for the experiment because it is not a main line. It is in the heart of the company's heaviest traffic, that from the suburban stations on the south side of the metropolis to London Bridge and Victoria, as many as seven millions of passengers being conveyed annually from that district to the London termini. The "shuttle service," which is first contemplated, will be run between the hours of 9 or 10 in the morning and 4 or 5 in the afternoon, passengers changing cars at each end. In this way the convenience of the early workers will not be interfered with. If the directorate are able to convince the Board of Trade that the electrification is a decided improvement upon the present system, about which the general manager appears to entertain a very decided opinion, the scheme will be extended on the main line to London Bridge and Victoria. At first the company will have to seek outside power to run the experiment, but an electric power-station is being built at New Cross for other electrical requirements of the company, which will be available for working this interesting development and its extension, whenever required. The officers of the company have strong objections to the use of the third-rail system on their railway, and they believe that the single-phase system with an overhead conductor will be both safer and cheaper. Of course it is only the development of the single-phase motor within the last year or two which has made the project feasible. Both on the Continent and in America single-phase railway motors have been evolved which are said to give every satisfaction in traction work. The primary great advantage which such a system, if otherwise desirable, presents is the abolition of sub-stations. The high-tension current is led direct along the overhead conductor, and a transformer carried in the train reduces the pressure before the current enters the motors. As the current is alternating throughout, no rotary converters are required. Of course, on a railway of considerable length switchboard stations might possibly be required here and there, but there would be no moving machinery in them.

TRAMWAYS ASSOCIATION AND THE CENTRAL LONDON RAILWAY.

Under arrangement made by Mr. E. Benedict, the secretary, members of the Tramways and Light Railways Association paid a visit on January 16 to the power-station of the Central London Railway. The party assembled at Oxford Circus Station, where they were received by Mr. G. C. Cuningham, general manager of the railway. They were then conveyed in a reserved car on one of the trains to Shepherd's Bush. After the ordinary passengers had alighted, the train with the members of the Association was run up the incline to the depôt and right into one of the car sheds. Walking over to the generating station, the boiler-house was first inspected. The furnaces are hand-fired, and it was stated that the results are believed to be better than when mechanical stokers are used. The coal is raised by a conveyor to overhead bunkers in the usual way, and the coal shoots lead the fuel down to the firing floor in front of the furnaces. Passing on to the engine-room, the members inspected the main engines and three-phase generators, and afterwards had the leading arrangements of the switchboard pointed out to them. A visit was next paid to the repairing shops, where some of the discarded electric locomotives were still to be seen. On returning to the car shed the members were shown some of the steel cars which have been in service for the past eighteen months. In general appearance they do not differ from the wood cars, and the internal fittings are of wood. Each, however, is 12 cwt. lighter than the ordinary car, and owing to the thinness of the walls the inside width is 4½ in. greater than that of the wood cars. On the return journey some of the members had an opportunity of travelling in the driver's cab in the front of the train, where they could see how the Thomson-Houston multiple-unit control behaves in service. The lights in the tunnels were turned on to show their appearance if required in a case of emergency. At Bond Street Station the party left the train and were shown the sub-station there. This is the newest of the sub-stations on the line, and instead of being placed in the bottom of the lift shaft, as in other cases, it is housed in a building on the street level. This sub-station, besides containing the usual transformers, converters, and switchboard, has also two motor-generators, which are used to boost up the pressure on the lighting circuits of the railway, the whole of the passenger stations being supplied with lighting current from Bond Street. The members of the Association subsequently proceeded to the City, well satisfied with their visit.

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PERSONAL.

Mr. Harold W. Seymour has been appointed to the post of car-shed superintendent at Blackburn.

Mr. A. J. Abraham, of Partick, has been appointed electrical engineer to the Lanark County Council.

Mr. J. D. Allen, assistant engineer of the Lanarkshire Tramways Company, has been presented by the employees with a handsome drawing-room clock, on the occasion of his marriage.

Lord George Hamilton, M.P., and Mr. J. Clifton Robinson have been elected directors of the Underground Electric Railways Company of London.

Mr. G S. B. Andrews, deputy town engineer, has been appointed chief engineer to Johannesburg Town Council, in place of Mr. D. Leitch, who has resigned. The salary is £1,800 per annum.

Mr. R. B. Leach, late assistant engineer, has been appointed chief engineer and manager of the Farnworth Urban District Council's electricity and tramways undertakings.

The Rt. Hon. J. Lloyd Wharton, M.P., has been elected vice-chairman of the North Eastern Railway Company in succession to the late Sir Lowthian Bell.

Mr. Joseph Carter has been appointed secretary of the Metropolitan District Railway, in the place of Mr. William Jones, who retired at the end of the year.

Mr. F. R. Davenport, who for many years has been with the British Thomson-Houston Company, and latterly manager of their London office, has accepted a position with the firm of Peter Brotherhood, engineers, Westminster.

Mr. A. Walkington has been granted an honorarium of £20 by the Stalybridge, Hyde, Mossley and Dunkinfield Tramways and Electricity Board upon the temination on December 31 of his engagement as chief clerk to the engineer-in-chief during the consulting period of three years.

Mr. R. L. Acland, electrical engineer to the Chesterfield Corporation, has been appointed to the joint offices of electrical engineer and tramway manager, at a salary of £350 per annum, rising to £400 at the expiration of a year.

Mr. I. E. Winslow, of 20, Bishopsgate Street, E.C , has been appointed by the Coventry Electric Tramway Company to superintend the construction of about three miles of new tramways and the reconstruction of five and a-half miles of existing tramways.

Mr. J. F. I. Thomas, who was appointed by Messrs. Mordey and Dawbarn as their resident engineer in connection with the Johannesburg electric lighting and tramway scheme, has arrived in Johannesburg, and has taken up his duties.

Mr. James C. Inglis, general manager of the Great Western Railway, has been nominated by the Council of the Institution of Civil Engineers as one of their representatives on the Engineering Standards Committee, in the place of the late Mr. John Allen McDonald, engineer-in-chief of the Midland Railway.

Mr. John Elliot has been appointed superintendent of the Midland Railway, in succession to Mr. T. Eaton. Mr. Elliot was formerly passenger agent at St. Pancras. In October, 1901, he was appointed London district superintendent, and two years ago became outdoor assistant superintendent of the line.

Mr. H. A. Neville, assistant electrical engineer to Wakefield Corporation, has been recommended to the Council by the Electric Lighting Committee for the position of borough electrical engineer from April 1, at a salary of £300 a year, rising by annual increments of £25 to £400 per annum.

Mr. A. A. Blackburn, who, as we recently announced, is leaving Manchester in order to take up an appointment on the Belfast Corporation Tramways, was, on January 28, the recipient of a testimonial from the employees of the Manchester Corporation Tramways, with whom he has been associated during the past two and a half years.

Mr. Frank Armstrong, chief inspector of the Bolton Corporation Tramways, has been appointed traffic superintendent of the Walthamstow Tramways, at a salary of £150. The remuneration appears quite inadequate, and we are glad to note that it will be reconsidered by the Walthamstow Urban District Council three months after the opening of the tramways.

Mr. Lewis D. Tandy, an American electrical engineer, who has been resident in London for a number of years, has been appointed general manager of the Singapore Electrical Tramways Company. This company, which has a capital of £650,000, will commence its operations in April next. It will initiate the first system of electrical tramways in Singapore, and will at the same time provide the city with electric light.

Mr. C. W. Shepherd, traffic superintendent of the Edinburgh and District Tramway Company, was on January 13 presented by the employees with a gold watch, as a mark of their appreciation of his efforts in raising a fund in aid of the widows and orphans of the tramwaymen. Since the fund was started in October, 1903, the sum of £90 has been paid away, while at the present time five widows and fifteen children are receiving relief at the rate of from 7s. 6d. to 10s. a week.

Mr. E. H. Mottram, general manager of the Poole and District Electric Traction Company, was presented by the employees on January 5 with a handsome clock as a token of their esteem. The occasion was the third annual dinner of the company's employees, and it will probably be the last under the old *régime*, as the tramways will shortly be acquired by the Bournemouth Town Council. A hope was expressed that Mr. Mottram would retain the managership under the Corporation.

Mr. Henry Evans, formerly goods manager of the Glasgow and South Western Railway, who has recently been appointed chief goods manager of the Midland Railway, was presented on January 20, at St. Enoch Station Hotel, Glasgow, with a massive silver salver of early English design, with rich scroll border and feet, and four silver candlesticks *en suite*, together with a diamond pendant for Mrs. Evans, from the employees of the Glasgow and South Western Railway, as a token of their esteem.

Mr. M. Rathborne, who has for some time been the general manager of the Middleton Electric Traction Company and the Oldham, Ashton, and Hyde Tramway Company, is now devoting the whole of his time to the management of the latter undertaking. The employees of the Middleton Electric Traction Company have made him a presentation, consisting of a liquor case and gold ring, and in doing so expressed the regret they felt at his leaving them, and spoke of the high appreciation they had of his management

Mr. Stanley J. Leech has resigned his appointment with the British Electric Traction Company as manager and engineer of their Weston-Super-Mare and District Electric Supply Company. He has held the appointment for five years, superintending all the original construction work, power house, mains, etc., and later, the equipment of the tramways, and managing all departments. He has resigned in order to enter into partnership with Messrs. J. B. Saunders and Company, of 1, Palmer Street, Westminster, railway telegraph engineers and general contractors. His new address is 1, James Street, Cardiff.

Mr. M. H. Volk has resigned his position as works engineer to the Brighton Corporation Tramways Department, which he has held for the past three years, to take up an appointment as engineer and manager to the Brighton Beach Electric Railway. On January 20, Mr. Volk was presented with a splendid case of drawing instruments and a book on railway working. On making the presentation on behalf of the office staff, Mr. T. B. Holliday, tramways engineer and general manager, expressed regret on losing Mr. Volk, but wished him every success in his new career. Mr. Volk was also the recipient of a handsome walking-stick from the works staff.

Mr. W. R. Hederstedt, of London, has been appointed chief officer of the Exeter Corporation Tramways (now under construction), for a period of twelve months, at an inclusive salary of £400 for three months' continuous service and nine months' consultative and advisory services. Mr. Hederstedt was formerly deputy-engineer of the British Electric Traction Company, and has since been connected with the London County Council tramways department. He has also had considerable experience in India, supervising the construction of railways and tramways, and is a nephew of the former chief engineer of the Oudh and Rohilcund Railway.

Newcastle Tramways Managership.—The Newcastle Tramways Committee on January 20 reduced the number of applicants for the managership of the tramways to five, these being:

Mr. H. E. Yerbury, chief engineer and deputy manager of Sheffield Tramways.
Mr. C. J. Spencer, general manager of Bradford Tramways.
Mr. C. W. Mallins, superintendent and deputy manager Liverpool Tramways.
Mr. Ernest Hatton, general manager Salford Tramways.
Mr. G. Conaty, manager of Birmingham and Midland Tramways.

On January 30 the Committee still further reduced the number of candidates for the post of tramways manager. The City Council have now to make a selection from Messrs. G. Conaty, E. Hatton, and H. E. Yerbury, It was expected that the appointment would be made at the Council's meeting on February 1, but the matter has now been deferred in order that a deputation may visit the cities where the candidates are now employed.

Tramways Association. Mr. H. M. Sayers, M.I.M.E., read a paper before the Tramways and Light Railways Association on January 13, in which he dealt with the choice of materials and the design of parts required in tramway overhead construction. Pressure on space obliges us to postpone further reference to the paper at present.

The Dolter Surface Contact System.—By invitation of the Birmingham City Association, an exhibition of the Dolter system was given in the end of January at the Grand Hotel, Birmingham. The system, which was illustrated by a working model, has been installed in Paris for more than three years, a trial line is working at Dresden, and it is being introduced into Torquay. The model, which demonstrated the easy running of the cars, was under the supervision of Mr. H. Lancaster, representing the company; a full-sized stud with the iron skates at work being shown alongside. It is noteworthy that the system can be worked practically without interruption in connection with a route having the overhead equipment.

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NEW CONTRACTS AND ORDERS.

Norwich Town Council have accepted the tender of Messrs. C. A. Parsons and Company, for a 1,000 KW. steam turbo-generator at £6,400

Swindon Corporation have accepted the tender of Messrs. Davey, Paxman and Company, of Colchester, for a new generating set at £2,068.

Yarmouth Town Council have accepted the tender of the Albion Clay Company, of Woodville, Burton-on-Trent, for conduits at 5s. 6d. per yard.

Messrs. Pearson, Huggins and Company, Limited, of 51, Scrutton Street, Finsbury, E.C., have secured the contract for the supply of uniforms for the motor-men and conductors of the Cardiff Corporation Tramways.

Stockport Corporation have accepted the tender of Walter Scott, Limited, for tramway rails, and that of the Cooper Patent Anchor Joint Company for rail joints.

Yarmouth Corporation have accepted the tender of Millar's Karri and Jarrah Company, Limited, for the supply of 1¼ million Jarrah blocks for the Gorleston tramways at £7 18s. 3d. per 1,000.

West Ham Corporation have ordered 34 car bodies from the Brush Electrical Engineering Company, and one car complete with radial action truck and Raworth's regenerative control equipment.

Messrs. C. A. Parsons and Company, of Newcastle-on-Tyne, have received an order from the Whitby Urban District Council for a 200 KW. steam turbine at £1,550.

The Brush Electrical Engineering Company Limited, have secured a contract from the Birmingham and Midland Tramways for the supply of 32 traction motors.

Messrs. S. Dixon and Son, of Leeds, have received an order for the installation of Turner's automatic point controller on the Rotherham Corporation Tramways.

Messrs. Askham Brothers and Wilson, of Sheffield, have received an order from Yarmouth Corporation for the points and crossings required on the Gorleston and Southtown Tramways.

Cardiff Electric Lighting Committee have accepted the tender of the General Electric Company for two 1,100 KW. generators at £3,114, and that of J. Musgrave and Sons for two 1,600 I.H.P. engines at £14,304.

Mr. Jas. W. Courtenay, of Amberley House, Norfolk Street, Strand, W.C., has been appointed sole advertising contractor for the Musselburgh Electric Tramways.

The Forest City Electric Company, of 3, Gore Street, Piccadilly, Manchester, have supplied their "Protected" rail bonds to the Leith and Belfast Corporations for the tramways now under construction.

Durban Tramways Department have placed orders with the Lancashire Dynamo and Motor Company for a booster, and with the Tudor Storage Battery Syndicate for a battery of 250 cells of 770 ampere-hours capacity.

The Railway and General Engineering Company, Limited, of Nottingham, have received orders for rail grinders from the London County Council and from the Cape Electric Tramways. They also recently supplied one of these machines to the Halifax Corporation.

The London General Omnibus Company have ordered six motor 'buses from the Wolseley Company, to be ready by the end of March. The Great Western Railway Company and the Birmingham Motor Express Company have also ordered motor 'buses from the Wolseley firm.

Messrs. Hudson and Bowring, of Manchester, have secured contracts from the following, for the fitting of cars with their "H.B." life-guards, viz.: Birmingham and Midland Tramways, Chesterfield Corporation Tramways, Lincoln Corporation Tramways, and Penang Electric Tramways.

The British Electric Equipment Company, Limited, have the contract for the construction of the permanent way, overhead equipment, and the laying of feeder cables for the Dover and River light railways, which are being added to the Dover Corporation tramway system.

Glasgow Tramways Committee have recommended that the tender of the British Westinghouse Company for the supply of motor equipments and spare parts for 100 electric cars should be accepted, and that the tender of the same firm for 100 sets of the Westinghouse magnetic brake should also be accepted.

Perth Electricity Committee have accepted the tender of the British Electric Plant Company, of Alloa, N.B., for the engine and dynamo required at the power-station in connection with the electrification of the tramways. The tender of Messrs. Cowan and Company, of Salford, for the tramways switchboard has also been accepted.

Tramcars for the Argentine.—Messrs. Dick, Kerr and Company are shipping 150 cars to the La Capital Tramways Company of Buenos Ayres. These cars are of the new Preston double-service type. The company have orders for additional cars of the same type from the Buenos Ayres and Belgrano, and the Buenos Ayres Electric Tramway Companies.

The Brush Electrical Engineering Company, Limited, have received through Messrs. Greenwood and Batley an order for four cars, to be equipped with British Thomson-Houston motors, for the Colne and Trawden light railways. The Brush Company have also received orders from the Midland Electric Power Distribution Corporation for four 60 KW. transformers and four 25 KW. transformers.

Cable Tramway Economies.—It is reported that very considerable economies have been lately effected in some of the Edinburgh and District Tramway Company's contracts. In the case of cables alone there is said to be a saving of upwards of 25 per cent., or at the rate of more than £2,000 a year. In other directions also a material saving is expected to be made, besides improvements, which tend to increase the efficiency of the service.

Roller Bearings.—The test train on the London, Brighton and South Coast Railway fitted with roller bearing axle boxes continues to run very satisfactorily, and marked economies in coal consumption are being effected. As a result the Empire Roller Bearings Company, Limited, are now supplying axle-boxes for experimental trains on the Furness Railway and Barry Railway, and are in negotiation for similar orders from the Liverpool Overhead Railway, and the Midland and Great Northern Joint Railway.

Glasgow Tramways Committee have accepted the following tenders:

Rails	Messrs. Bolckow, Vaughan, and Company.
Fans and motors	Messrs. Bergthell and Young.
Relays	The Ericsson Bell Telephone Company.
Springs for Newell brakes...	Messrs. L. Sterne and Company, Limited.
Ears for trolley wire under bridges	The British Johns-Manville Company, Limited.
Timber for cars	Messrs. J. Cameron and Company and Messrs. Buchanan and French.
Additional motor for Coplawhill car works	The British Westinghouse Company, Limited.

Fremantle, W.A.—The *Australian Mining Standard* reports that in connection with the Fremantle (W.A.) Electric Tramway, Messrs. Noyes Brothers, electrical engineers, have informed the Board that orders for machinery have been placed as follows:

Four engines, Belliss and Morcom, Birmingham.
Fourteen cars, Brill, Philadelphia.
Cables, trolley wire and bonds, J. G. White, London.
Generator, motors, meters, lamps, transformers, switchboards, Westinghouse Company, Manchester.

Messrs. J. G. White and Company had placed an order for the rails with the United States Steel Products Export Company.

Erith's Tramway Cars. The British Westinghouse Company were the successful tenderers for the 14 tramway cars (one top-deck) required by Erith U.D.C. The cars will have Brush bodies and Mountain and Gibson trucks. The following is a list of the tenders received:

	Tramcars.	Track sweeper, etc.
British Westinghouse Company (accepted) ...	£8,522	£626
Mountain and Gibson	-	650
British Thomson-Houston Company	8,189	608
Dick, Kerr and Company, Limited	8,935	668
Hurst, Nelson, and Company	7,528	658
Brush Electrical Engineering Company ...	8,278	680
St. Louis Car Company	9,270	- -
Witting, Eborall, and Company	7,682	573

The Leith Tramway Car Contract.—A decision of the Tramways Committee of Leith Corporation to accept the Brush Electrical Engineering Company's tender for the cars and equipment required in connection with the reconstruction of the system has been overruled by the Town Council. The Committee, which consists of the whole Council, had full powers to deal with the contracts, and their decision was regarded as final. A number of the Councillors, however, requisitioned a special meeting of the Council to consider the matter, on the ground that only 15 out of 18 members of the Committee were present when the vote was taken. The Town Council met on January 16, and reconsidered at length the Brush Company's offer to supply the cars at £19,228, and the British Thomson-Houston Company's tender at £18,978 10s. After an acrimonious discussion a compromise was agreed to unanimously, by which the contract was divided about equally between the two companies mentioned.

Reconstruction of Belfast Tramways.—A special meeting of the Belfast Tramways and Electricity Committee was held on January 11, in connection with the preparation of the contract with Messrs. J. G. White and Company, and its signature by both parties. Mr. John White and Mr. A. H. Beatty, who represented the contractors, undertook to have all the sections, including the third engine, for which a period of 10 months had been allowed, ready within nine months from December 3. In return, the Committee, in consideration of this expedition, agreed to reduce the amount of detention money by 50 per cent. in excess of £54,000, the contractors, in addition to their own guarantee

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of responsibility, having entered into a bail bond for £25,000. Messrs. White's representatives, in reply to the town clerk, also stated that they expected to be in a position to commence the street work on February 1, and to push rapidly ahead. They wished to inconvenience the city of Belfast and its traffic as little as possible, and consequently did not intend to open up thoroughfares until they had all the material ready for the rapid completion of the permanent way.

FINANCIAL REPORTS.

Blackpool and Fleetwood Tramroad Company. The accounts show a balance of £10,426 available for distribution. A final dividend of 6½ per cent. is recommended, making 9 per cent. for the past year.

Scarborough South Cliff Tramway Company.—The annual report states that there has been an increase in the receipts of £20, and that the available balance amounts to £469 10s. From this a dividend of 5 per cent. is recommended.

Woolwich, Blackheath, Eltham and District Motor Company, Limited.—Under this style, a company is being formed with a capital of £20,000, with the object of establishing a motor omnibus service to cover a considerable area of the Woolwich district.

The Waterloo and City Railway dividend on the ordinary stock is at the rate of 3¼ per cent. per annum for the past half-year, carrying forward a balance of £255. A year ago the distribution was at the rate of 3 per cent., with £355 carried over.

Metropolitan District Railway. The directors have decided to recommend a dividend at the rate of 1¾ per cent. per annum for the past half-year on the 4 per cent. guaranteed stock. The dividend for the corresponding period of 1903 was at the rate of 1½ per cent.

London Road Car Company.—The directors announce a dividend for the half-year ended December 31 at the rate of 4s. per share (equal to about 6½ per cent. per annum) and to carry forward about £4,800. For the half-year to December, 1903, the dividend was at the rate of 7 per cent. per annum.

London General Omnibus Company.—It is proposed to pay a dividend at the rate of 8 per cent. per annum, free of income-tax, for the half-year ended December 31, to carry £20,000 to motor fund account, and £11,296 forward. A year ago the dividend was at the same rate.

North Metropolitan Tramways Company.—For the half-year ended December 31 the directors have declared a dividend at the rate of 4 per cent. per annum, carrying forward about £230 to next account. During the half-year the number of miles run were 6,994,775, and passengers carried 67,054,611.

City of York Tramways Company.—The report just issued covers the half-year ended December 31 last. The receipts amounted to £1,968 and the expenses to £1,736, leaving a profit of £232. After paying debenture interest, £90 remains, which it is proposed to carry to the suspense account for reconstruction of the lines.

Stockport and Hazel Grove Tramways Company, Limited.—The Hazel Grove tramways, having been purchased by the Stockport Corporation for £24,000, the company has gone into liquidation after 15 years' satisfactory working, and the shareholders are to receive 27s. per share, and 10 per cent. from the date of the last dividend.

Liverpool Overhead Railway Company.—The accounts of this company for the past half-year show an available balance of £10,134 18s. 6d., and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares, and 1¼ per cent. per annum on the ordinary shares against 1½ per cent. per annum on the ordinary shares for the corresponding period last year. The balance carried forward is £3,743 as against £4,132 last year.

Shanghai Electric Tramways, Limited.—This company was registered on January 2, by Ingle, Holmes, Sons and Pott, Broad Street House, E.C., with a capital of £10,000. Its object is to acquire, equip, maintain, and work by electrical, steam, horse, or other power, tramways, railways, boats, and other means of communication in Shanghai or elsewhere in Asia, and to carry on the business of electricians and distributors of electrical energy for light, heat, motive power, or otherwise, etc.

The London Motor Omnibus Company, Limited, is a new company with a capital of £103,000, in 100,000 ordinary shares of £1 and 60,000 deferred shares of 1s. The company has been formed primarily for the purpose of establishing a system of motor omnibuses in London. The Motor Omnibus Trust, Limited, who are the promotors of and vendors to this company, have stipulated for the allotment to them of the whole of the deferred shares of this company as fully paid, and the option to subscribe for certain ordinary shares.

The London Road Car Company have issued the balance of the share capital, £116,004, in 19,334 shares of £6 each at par. The issue will rank for dividend in all respects on an equality with the existing share capital, and will carry dividends from the respective dates of payment of instalments. The issue of shares is for the purpose of providing and equipping new motor road-cars and adapting the company's depôts to the altered conditions under which the company's traffic is proposed to be carried on.

Edinburgh and District Tramways Company, Limited.—The directors' report covers the year ended December 31 last. The total receipts amount to £239,499 as compared with £227,793 during 1903, an increase of £11,706, while the total expenses at £223,456 show an increase of £7,442 over the previous year. A profit is thus shown of £16,043, or £4,263 more than last year. After making provision for the rent up to December 31 last, and also for the interest on the debentures, etc., there remains at the credit of the net revenue account a balance of £11,052 11s. 4d., which has been carried to suspense account.

Barsi Light Railway Company, Limited.—A further issue is announced by this company of £225,000 in shares of £10 each, the price of issue being par. The company was formed in 1895 to acquire a concession granted by the Secretary of State for India in Council for a light railway from the Bársi Road Station of the Great Indian Peninsula Railway (between Poona and Sholapur) to the town of Bársi, and to construct and work this line and any extensions which might from time to time be sanctioned. Since the opening of the line dividends have been steadily paid at rates ranging from 2 per cent. in 1898 to 5½ per cent. in 1904.

Central London Railway.—The report of the directors for the half-year ended December 31 last states that the total receipts were £176,281, being an increase of £1,046, and the working expenses £95,938, a decrease of £1,426, leaving a balance of £80,344. The number of passengers was 21,906,150, compared with 21,774,850. After providing for debenture interest, etc., the net revenue account shows a balance of £122,580, and the directors recommend dividends at the rate of 4 per cent. per annum on the ordinary, preferred, and deferred stocks. A sum of £30,000 is transferred to reserve, and the balance of £22,112 is carried forward.

Giants' Causeway, Portrush and Bush Valley Railway and Tramway Company.—The directors report a large increase in the receipts during the year ended December 31 last—the 22nd year since the line was opened. The total receipts amounted to £3,636, against £3,376 in 1903, the number of passengers having increased from 108,154 to 119,876. The net profit on the year's working was £1,479, as against £1,241 in the previous year. The number of miles run by electricity were 28,489, against 22,954 in 1903, and 5,803 miles were worked by steam, as against 7,560 previously. The increased electric mileage and diminished steam mileage have given most favourable results.

Great Northern and City Railway.—The directors report that the traffic receipts during the half-year ended December 31 last amounted to £36,509, as against £19,304 for the previous 4½ months. The numbers of passengers carried for the same periods, excluding season ticket holders, were 5,227,595 and 2,711,152 respectively. 2,511 local season tickets were issued during the half-year. Through booking arrangements have been made with the Great Northern Railway Company, and the public have availed themselves largely of these facilities. By a supplemental agreement with the contractors, the working expenses retainable by them will be calculated for the first year of working at the rate of 60 per cent., and for the second and third years at 50 per cent. of the gross receipts.

Dublin United Tramways Company (1896), Limited.—The report for the half-year ended December 31 last, states that the amount available for division is £50,313, out of which dividends for the half-year are recommended at the rate of 6 per cent. per annum on the preference and ordinary shares. It is proposed to write off £3,365, balance of the cost of the electric welding of the Dalkey line, to place £4,000 to reserve fund, and £1,000 to accident insurance fund, leaving £6,847 to be carried forward. A special meeting will be held after the ordinary meeting to consider a Bill promoted in Parliament for the transfer of the undertakings of the Dublin United Tramways Company and the Dublin Southern District Tramways Company to the Dublin United Tramways Company (1896), Limited.

Accrington Corporation Steam Tramways Company.—The directors report an increase of £164 6s. 6d. in traffic and parcel receipts during the year ended December 31 last. The gross receipts for the year were £18,142, as compared with £17,939 10s. last year, being an increase of £202 10s. The working expenses have increased by £647, being £12,783 this year, and last year £12 136. This increase in expenditure arises through extra cost on rolling stock and permanent way. The revenue account shows a profit of £5,358, and adding £31 balance from last year, makes an available amount of £5,389. From this sum the directors have paid an interim dividend, in July last, of 6 per cent. to the ordinary and preference shareholders, amounting to

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£1,504, and have written off £979, as per profit and loss account, and transferred to depreciation and reserve account £1,300. After paying and writing off the above sums, there is an available amount of £1,605, with which the directors propose to pay dividends of 6 per cent. to both preference and ordinary shareholders for the half-year ended December 31 last. This will absorb £1,501, leaving a balance of £104 to carry forward.

London Underground Railway Dividends.—We give below the dividends of the London tube railways, and of the Metropolitan and Metropolitan District (Pref.) for the last four years. The Central London has evidently become a steady 4 per cent. investment, and were it not for the uncertainty as to the future development of the underground railway system in London, the ordinary shares, which are now quoted at 92, would be well above parity. Considering the district served by the Central London, it is, however, unlikely that it will be seriously affected by other lines, and the shares offer advantages to the investor who does not mind locking up his money.

NAME.	1904.		1903.		1902.		1901.	
	2nd Half.	1st Half.	2nd Half.	1st Half	2nd Half.	1st Half.	2nd Half.	1st Half.
Central London	4	4	4	4	4	4	4	4
City and S. London	1¾	2½	2	2¾	3½	3	2¼	1¾
Metropolitan	3	3	3	2½	2½	2¼	2¼	2¼
Met. Dist. Pref.	nil.	nil.	nil.	nil.	nil.	nil.	nil.	nil.
Waterloo and City	3¼	3	3	3¼	3¼	3	3	3

City and South London Railway Company.—The report of this company for the half-year ended December 31 states that the receipts from all sources amounted to £74,891, and the cost of working to £35,368, leaving a profit of £39,523. The balance available for distribution is £40,224, and a dividend at the rate of 1¾ per cent. per annum is proposed on the ordinary stock, leaving £1,449 to be carried forward. The directors regret that there has been a decrease in the traffic compared with the corresponding period of 1903, but they are of opinion that this is attributable to the exceptionally fine and dry weather which prevailed during the greater part of last half-year, whereas the weather in the previous year was unusually wet. A slight diminution in the dividend is unfortunately the result. The arrangements with the various railway companies in respect to the Euston extension being now completed, a contract will be entered into for the construction of the extension. In providing the capital necessary for the work it is found to be more economical to issue the stocks authorised at the last meeting as part of and ranking with the other stocks of the company, and liable to dividend in the usual course, but arrangements are in progress by which the amount payable as dividend on these stocks will, it is anticipated, be met by receipts from other sources. The interchange traffic with the Great Northern and City Railway is increasing satisfactorily, and through bookings over this line with the suburban stations of the Great Northern Railway are now in operation.

Metropolitan Railway Company.—The report of the Metropolitan Railway Company states that the total receipts for the half-year ending December 31 were £439,595, and the expenses £214,128, leaving a profit of £225,466. The receipts show an increase of £939, and the expenses an increase of £6,350 compared with the corresponding half of 1903. The net revenue account, after providing for interest upon the debenture stocks and other fixed charges, and crediting £10,000 to a special reserve fund for the renovation of stations, etc., shows a balance of £188,652, which will suffice for the dividends upon the preference stocks and leave £97,266 available for dividend upon the ordinary stock, upon which a distribution at the rate of 3 per cent. per annum is proposed, carrying forward £11,285 to the next half-year's accounts. The dividend on the surplus lands stock for the past half-year will be at the rate of 2¾ per cent. per annum. The installation at the power-station at Neasden is so far completed as to enable a service of electric trains to be run between Baker Street and Uxbridge, and the number of such trains is being gradually increased. This working was commenced on January 1, and it is intended shortly to run the whole service on this section by electrically driven trains. The work on the Inner Circle is being proceeded with rapidly, and electric traction will follow on there as soon as the equipment is finished.—At the half-yearly meeting of the company, on January 27, at which the report was adopted, Sir C. McLaren, the chairman, referred to the inauguration of electric traction on the company's lines. He said that they started a public service of electric trains on January 1. These trains were now running regularly, and they had been rewarded with an increase in traffic. They had so far completed the electrical equipment of the line as to admit of the working of a portion of the trains between Baker Street station and Uxbridge by the new method of traction. They were gradually increasing the number of electric trains, and hoped shortly to be able to dispense with steam entirely on that section. So far as the Inner Circle service was concerned, they hoped very soon to run some electric trains. The District Company were also well forward with their installation, so that they might reasonably expect, in the near future, to see the trains on the Circle driven by the new power. Their contractors hoped to enable the Metropolitan to run a few trains as early as March. In the new trains there were two classes only, and this meant ultimately abolishing second-class entirely on the Circle trains and on the trains between Baker Street and Uxbridge. They proposed at the same time to reduce first-class fares, so that they should, speaking generally, not exceed the third by more than one half. The affairs of the company were progressing very satisfactorily, and when they got the new mode of working thoroughly established, the prospects would be good.

TRAMWAY AND LIGHT RAILWAY NOTES.

BELFAST.—The Corporation have decided in favour of free passes for Town Councillors on the tramways.

BRADFORD.—Arising out of a discussion which took place at a previous meeting of the Bradford City Council with regard to the discretionary powers of the general manager of the tramways department to suspend or discharge employees, and the question which was then raised as to the possibility of an appeal to the Committee, the matter came up for consideration on January 16 at a meeting of the Tramways Committee. Special reference was made to the interpretation of Rule 9 of the tramway regulations, which deals with the manner in which employees may be dealt with. Eventually the Committee decided to allow the principle of appeal to the Committee in cases of dismissal, and a Sub-committee, including the chairman and deputy-chairman, was appointed to formulate rules under which appeals may be entertained by the Committee.

BURTON AND ASHBY.—At Stanhope Bretby, a hundred yards or so outside the Swadlincote district, a definite start has been made on the construction of the Burton to Ashby light railway. A large number of men are now employed. Messrs. Dick, Kerr and Company have taken offices in Swadlincote, and have staked off the ground in other places for a start all along the route.

COLCHESTER.—On January 18 and 20 the Colchester tramway employees were entertained as guests at a supper and smoking concert kindly provided through the good offices of local ladies. Mr. R. C. Bullough, general manager, was in the chair, and was supported by the Mayor (Alderman E. J. Sanders), and the chairman of the Tramways Committee (Mr. C. H. T. Marshall). Very pleasant evenings were spent. The Mayor and chairman addressed ths meetings, and the men were thanked for their courtesy and civility to the general public, and were complimented upon the way they carried out their duties having regard to the short time they had had to learn. It was worthy of note that while it had been said they would not carry 35,000 people a week, the actual figures average 60,000 weekly.

DURHAM.—The Sunderland District Electric Tramways, Limited, have arranged a contract for the supply of power to the important collieries in the county of Durham belonging to the Lambton Collieries, Limited, managed by Sir James Joicey, Bart., M.P., and formerly belonging to the Right Honourable the Earl of Durham, with Mr. A. Kirkup as chief mining engineer. It is proposed to use the power for hauling, pumping, coal cutting, lighting, and winding purposes, as well as for the engine works at Philadelphia, which will make these collieries one of the most up-to-date groups in the country. These collieries employ over 10,000 men, and have an output of over 3,000,000 tons per annum, besides owning a large fleet of steamers. It is proposed to erect a large central power-station on five acres of land at Philadelphia, from which the power will be taken to the collieries, and in addition the tramways, of which over 12 miles are now fully completed, will be supplied with the necessary power, as well as the supply of power for electric lighting in the urban districts of Houghton-le-Spring and Hetton-le-Hole and the rural district of Easington, over which the company has statutory lighting powers. The power-station will be one of the most up-to-date, and being close to the pit's mouth the power will be produced under the most advantageous conditions, and at a minimum cost to the consumer. The contract has been arranged by Messrs. Harper Brothers and Company, consulting engineers, of London, and Messrs. D. Balfour and Son, engineers, of Newcastle-on-Tyne, and an immediate start is to be made with the construction of the power-station.

LEEDS.—The Leeds Tramways Committee have proposed that all the penny stages throughout the city should be two miles in length. With regard to halfpenny fares it was decided that an experiment should be made on about two-thirds of a mile of track on a route to be selected. Upon the result of this test will depend whether the system of halfpenny fares shall be carried out all over the city.

LEICESTER.—The first of the new canopied cars for Leicester Corporation has given great satisfaction to those who have inspected it. It is considered to be a great improvement on some of the top covers which are in use in certain other towns. The canopy is a

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permanent structure. The lower deck is slightly lower than the ordinary car, and the upper deck is a replica of it. There are doors at each end, and windows which can be raised or lowered at the will of the conductor. The top of the car seats 34 passengers, 28 of whom will be under the canopy, where smoking will not be permitted. It is expected that the covered cars will be available for use on all the routes except the Fosse Road section. Messrs. Dick, Kerr and Company are constructing the new cars.

LONDON.—On January 14, under the presidency of Mr. A. L. C. Fell, chief officer, the Tramways Department of the London County Council held their annual dinner at Frascati's Restaurant, Oxford Street. Among the guests were Mr. G. L. Gomme, clerk of the Council; Mr. H. E. Haward, controller; and Mr. W. A. Blaxland, solicitor to the Council. Some eighty members of the staff were present. Mr. Haward, the controller, proposed the health of the tramways department. Mr. A. L. C. Fell responded, and gave some interesting figures showing the growth of traffic on the L.C.C. lines. Mr. Gomme, in replying to the toast of "Our Guests," pointed out how conducive to the establishment of good feelings between departments were social gatherings of the kind. Mr. Blaxland expressed his pleasure at again being the guest of the tramways department, with whom he, in an official capacity, came much into contact. One member of the staff proposed the health of the veterans, and this was responded to by Mr. Holland, who acts in the capacity of paymaster. Mr. J. H. Rider, the electrical engineer, and Mr. Bruce, the traffic manager, were also among the speakers. An excellent musical programme was given.

NEWCASTLE.—Newcastle Corporation have decided to fit two of their cars with top covers as an experiment. A small deputation from the Tramways Committee have visited some of the towns where top covers have been adopted, in order to glean information, and a favourable impression appears to have been created. At Leeds, for instance, they were informed that the receipts on the top-covered cars averaged 30s. a week more than on the ordinary cars. The dissatisfaction, to which we have previously alluded, expressed by passengers on the electrified lines of the North Eastern Railway Company at Newcastle, was emphasised by a protest meeting which was held in Newcastle on January 9 under the chairmanship of the Duke of Northumberland. The grievances are principally entertained by first-class passengers, who complain that on the trains running between Newcastle and the coast no first-class carriages are reserved, except in the case of expresses, which run very infrequently during the day, and that a clause has also been added to the 1905 passes, making them available for first-class carriages only when such carriages are provided. The Duke of Northumberland, in his opening speech, proposed five resolutions condemnatory of various phases of the North Eastern Company's tactics. He said that the blame for what had occurred lay entirely upon the directorate, whose idea seemed to be that the public were like so many cattle or sheep. The resolutions were unanimously carried, and the meeting formed itself into an association to secure the redress of the grievances alluded to.

RADCLIFFE AND WHITEFIELD.—The Board of Trade inspection of the Radcliffe and Whitefield tramway took place on January 3, and the opening ceremony on the following day, the ordinary service commencing immediately afterwards. The Bury and Radcliffe Councils are working the line, which provides continuous tramway communication between Radcliffe and Manchester, about eight miles, but for the present passengers have to change cars at Whitefield.

SALFORD.—A new type of tramway car has been ordered by Salford Corporation, and will be given a trial by the Tramways Committee. It is what is known as the combination type of car—one deck—and will differ from those of the Manchester Corporation in so far as passengers desiring open-air seats will be accommodated in the centre. Each end of the car will be closed. The advantage claimed for the outside passengers is that they will be protected from the inclement weather. There will be a passage from end to end of the car, thus obviating the necessity of the guard stepping out on the footboard to collect the fares. Cars somewhat similar in design are in use elsewhere. Altogether 20 new cars are on order—ten combination and ten covered cars, but provided the combination type is satisfactory it is not improbable that they will be adopted in preference to the double-deck cars. They would be able to run where, owing to the lowness of certain bridges, the latter cannot run.

WEST HAM.—Since the arbitrator heard the evidence arising out of the claim for approximately £105,000 by the North Metropolitan Tramways Company against the West Ham Corporation for the compulsory acquirement of the Swan Yard and Martin Street depôts, an arrangement has been come to between the parties on the following basis: No award to be made by the arbitrator; the Corporation to pay the tramways company £63,000 for the two depôts; the company to release the Corporation from all liability under the agreement dated February 10, 1903, with regard to the Bow granaries; and immediate possession to be given of Swan Yard.

PATENT LIST.

Specially abstracted for "The Tramway and Railway World" from the Official Journal of Patents.

∴ If the inventions have been communicated the names of the communicators are given below in italics.

Applications.

Applications for Letters Patent have been filed as follows:

40 Plough for electric conduit tramways—J. J. Attridge.
91 Seats for tramcars, etc.—C. Brawn.
181 Cash bags for tram conductors—A. E. Drake.
219 Holder for tramway tickets—J. W. Allen.
247 Apparatus for moving tramway points—P. S. Thompson (*S. Pastor and A. A. Boom*)
282 Holder for tramway tickets—H. Mitchell.
379 Ticket for tramways, etc.—B. Wild.
380 Insulated roller contact block for electric traction—W. Ainsley.
401 Under-running current collectors for electric railways—British Thomson-Houston Company (*General Electric Company*).
530 Electric railways and trains—H. Courteen.
571 Apparatus for checking the efficiency of electric train or car driving—W. McLellan and C. H. Merz.
617 Splicing ear for electric trolley wires—T. E. R. Phillips.
642 Lifeguards for tramcars, etc.—T. E. Kershaw.
689 Automatic current feeder for electric railways—R. Duckworth, H. Duckworth, and D. Kerr.
860 Trolley heads—J. A. Orme.
990 Route or destination indicators for tramcars, etc.—A. H. Gawthorp.
1,023 Glazed advertisement frame for tramcars, etc.—W. Green.
1,153 Current collecting devices for electrically propelled vehicles—O. H. Baldwin.
1,154 Devices for supplying current to electrically operated vehicles—O. H. Baldwin.
1,166 Tramway ticket clip (for attachment to sticks or umbrellas)—F. H. George.
1,224 Trolley retrievers for electric tramcars—C. J. Earll.
1,467 Apparatus for moving tramway points—S. Pastor and A. A. Boom.
1,568 Stoppage indicating apparatus for tramcars, etc.—C. W. Pilkington.
1,657 Single rail railways and tramways—C. Joly and C. C. Millar.
1,658 Electro-magnetic switch for electric railways on the sectional conductor system—E. Fenton.
1,715 Outside seats for tramcars—H. Sedgwick.
1,732 Controller and brake mechanism for electric road vehicles—S. A. Russell and E. Ford.

Specifications Accepted.

The following applications, of which the specifications have been published, are now open to opposition by prior patentees or any other persons interested:

1903.

27,493 Apparatus for operating points and signals on railways and tramways—Walker and Bidder.
28,059 Earth indicating apparatus for trolley standards, etc.—British Thomson-Houston Company and Cubitt.
25,908 Apparatus for treatment of tramway rails—Bennett and Moorwood.

1904.

2,182 Device for cleaning tramway rails—Fawdon.
2,554 Joints for tram rails—Firth.
19,234 Rail joint and electrical rail bond—Webber.
22,178 Joints for track rails—Wheatley (*Minor*).
24,722 Electric tramcars and lifeguards—Whittaker.
3,010 Electric traction on a road contact system—Ross and Matthews.
4,131 Tramcar brakes—Betteley.
4,274 Lifeguards for tramcars—Echte and Purdie.
4,307 Mechanism for operating tramway points—Bousfield (*Chesi*).
12,016 Apparatus for repairing worn rail heads at joints—Melaun.
15,343 Electric railways and tramways on overhead conductor system—Anderson and Dunne.
23,807 Trolley restorers—Calahan.
23,932 Trolley wire supports—Paton.
25,363 Tramways—Kenway.
716 Control and propulsion of vehicles propelled by electric motors—Raworth.
4,603 Tramcars—Stanley and Anger.
4,676 Insulators for the conductors of electric railways—H. P. Bradford, F. D. Ward, and H. C. Furniss.
17,535 Means for supporting and fixing tramway rails—Pollard.
215 Mechanism for transmitting motion to a speed indicator for tramcars, etc.—Paffard.

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TRAFFIC RETURNS.

TRAMWAY COMPANIES.	1904. WEEKS ENDING Jan. 2.	Jan. 9.	Jan. 16.	Jan. 23.	1904-5. WEEKS ENDING Dec. 31.	Jan. 7.	Jan. 14.	Jan. 21.	AGGREGATE. Wks.	1905.	Increase or Dec.
	£	£	£	£	£	£	£	£		£	£
Aberdeen Corporation	1,470	1,230	1,050	1,061	1,291	1,583	1,060	1,041	34	47,761	+ 5,770
Airdrie	...	...	...	...	192	288	176	180	3	579	—
Barcelona	1,656	1,681	1,522	1,497	2,159	2,010	1,944	1,878	3	5,832	+ 1,182
Barnsley	176	133	141	150	208	154	146	138	3	397	+ 13
Barrow	...	...	...	...	202	179	180	167	3	479	—
Belfast Street	2,270	...	...	...	2,636	...	...	...			—
Birmingham, City of	5,306	5,046	5,023	5,083	5,601	5,543	5,590	4,585	3	15,718	+ 566
Birmingham and Midland	821	801	803	798	1,212	1,121	1,087	963	3	2,943	+ 443
Blackpool and Fleetwood	223	188	159	190	223	179	167	151	3	498	— 102
Blackpool Corporation	336	287	268	255	337	336	330	256	42	44,435	+ 6,051
Blackpool, St. Anne's, and Lytham	173	184	137	142	137	185	123	111	11	1,480	— 106
Bolton Corporation	1,150	1,666	1,628	1,612	1,815	2,151	1,591	1,502	43	78,658	+ 301
Bournemouth Corporation	996	857	857	840	1,081	973	906	831	42	45,928	+ 2,168
Bradford Corporation											
Bristol	4,838	4,448	4,547	4,491	5,546	4,579	4,661	4,801	3	13,541	+ 55
Burnley Corporation	837	816	777	822	1,069	1,090	994	882	3	2,966	+ 551
Burton-on-Trent Corporation	320	294	294	269	344	312	390	254	42½	14,572	—
Calcutta	Rs. 40,230	39,092	37,740	34,083	44,463	48,838	44,012	41,095	3	133,945	+ 23,030
Carlisle, City of	199	175	169	166	184	189	152	132	3	473	— 37
Chatham and District	526	495	516	493	901	888	608	552	3	1,548	+ 44
Cork	377	415	396	398	640	605	409	397	3	1,111	— 93
Devonport	457	470	466	462	536	498	460	424	3	1,280	— 27
Dover Corporation	179	171	170	162	214	180	170	155	43	9,556	— 126
Dublin and Lucan	176	75	92	92	158	79	106	85	3	271	+ 11
Dublin United	4,284	3,783	4,393	4,312	4,908	3,915	4,507	4,291	3	12,714	+ 147
Dudley—Stourbridge	866	688	714	711	955	723	747	618	3	1,983	— 35
Dundee City	810	1,126	781	762	855	1,208	835	783	31	36,906	+ 1,547
East Ham U.D.C.	589	584	585	561	680	629	612	580	42	30,113	+ 1,611
Edinburgh and District	4,824	4,652	3,961	4,065	4,718	5,921	4,405	4,072	3	14,399	+ 1,730
Gateshead	1,009	833	839	851	976	977	837	805	3	2,389	+ 60
Glasgow Corporation	14,965	14,619	12,656	13,374	14,108	17,069	13,328	13,373	36	481,472	+ 23,134
Gravesend and Northfleet	220	207	207	200	245	188	198	175	3	512	— 51
Greenock—Port Glasgow	521	502	415	453	490	668	470	480	3	1,461	+ 201
Harrow Road and Paddington	240	225	230	225	264	227	236	191	3	654	— 26
Hartlepool	233	243	236	248	279	287	230	218	3	668	— 8
Hull Corporation	2,140	2,037	1,858	1,979	2,302	2,180	2,066	1,958	42	92,520	+ 10,849
Ilford Corporation	...	321	323	310	...	358	355	318	42½	19,084	+ 931
Ilkeston Corporation	105	114	120	109	91	102	97	91	43	5,783	—
Isle of Thanet	232	...	...	...	314	...	...	...	—	—	—
Kidderminster	126	90	90	84	138	93	98	88	3	252	—
Lanarkshire	570	873	486	523	836	813	569	578	3	1,955	+ 73
Leeds Corporation	5,270	4,795	4,877	5,020	5,747	5,298	5,247	4,929	43	247,010	+ 13,698
Liverpool Corporation	9,696	9,622	9,531	9,557	10,377	10,272	9,981	9,278	3	29,480	+ 790
London County Council	8,859	9,826	9,084	8,906	12,514	12,184	12,143	11,050	43½	538,012	+ 19,106
London General Omnibus	19,582	21,548	21,067	19,936	20,140	22,087	21,774	19,196	3	63,007	+ 456
London Road Car	6,408	7,130	7,009	6,618	6,294	7,190	7,137	6,840	3	20,667	— 90
Manchester Corporation	11,134	10,749	10,531	10,729	11,972	11,996	11,558	10,806	42	513,797	+ 23,066
Merthyr	214	170	187	172	268	171	178	132	3	451	+ 57
Metropolitan	...	...	1,067	1,096	...	...	1,988	1,780	3	5,275	+ 2,251
Middleton	278	235	228	237	288	269	252	240	3	696	+ 54
Newcastle-upon-Tyne	3,746	3,472	3,446	3,444	3,652	3,748	3,393	3,357	3	10,493	+ 131
North Metropolitan	10,528	11,094	10,834	10,415	11,043	11,010	10,707	9,652	3	31,369	— 1,052
Oldham—Ashton	543	476	471	478	517	499	477	461	3	1,327	+ 15
Oldham Corporation	1,026	1,021	1,059	1,030	1,453	1,353	1,363	1,306	43	53,516	+ 3,146
Peterborough	133	113	108	105	144	107	108	94	3	278	— 15
Poole	256	221	219	221	299	229	220	197	3	604	— 17
Potteries	1,548	1,465	1,560	1,558	1,924	1,718	1,687	1,504	3	4,470	+ 219
Rossendale Valley	177	171	155	154	194	203	179	161	3	543	+ 63
Rothesay	56	68	36	40	34	86	39	35	3	141	+ 17
Salford Corporation	3,984	3,569	3,443	3,705	4,088	3,997	3,735	3,683	42	172,690	+ 8,408
Sheerness	58	49	47	46	64	61	57	52	3	139	+ 21
Sheffield Corporation	4,020	4,037	4,148	4,217	5,190	4,567	4,349	4,178	43	200,721	+ 4,838
Southampton Corporation	811	845	855	844	918	859	853	794	42	41,163	— 2,355
Southport	289	292	280	281	235	256	226	186	3	622	— 27
South Staffordshire	1,186	658	699	655	821	650	642	567	3	1,781	— 108
Sunderland Corporation	1,231	1,035	1,013	1,024	...	...	1,088	1,018	42	53,607	+ 1,381
Swansea	555	450	460	426	656	467	450	420	3	1,218	— 5
Taunton	56	47	49	44	69	42	41	43	3	115	— 13
Tynemouth	239	200	196	196	197	190	164	150	3	470	— 88
Tyneside Tramways and Tramroads	328	217	249	299	367	365	316	265	3	824	+ 58
Wallasey U.D. Council	587	584	594	578	680	690	653	560	42	31,660	+ 2,088
West Ham Corporation	...	...	...	...	1,261	1,076	1,110	968	47	45,194	—
Weston-super-Mare	26	18	19	24	33	27	29	31	3	72	+ 21
Wolverhampton Corporation	...	...	392	389	...	...	614	657			—
Wolverhampton District	423	301	318	328	466	360	335	286	3	905	+ 32
Worcester	117	104	106	106	330	271	262	212	3	684	+ 390
Wrexham and District	125	89	96	97	135	91	91	81	3	239	— 20
Yorkshire (Woollen) District	605	464	504	517	693	582	542	518	3	1,459	+ 100

RAILWAY COMPANIES.	1904. WEEKS ENDING Jan. 2.	Jan. 9.	Jan. 16.	Jan. 23.	1904-5. WEEKS ENDING Dec. 31.	Jan. 7.	Jan. 14.	Jan. 21.	AGGREGATE. Wks.	1905.	Increase or Dec.
	£	£	£	£	£	£	£	£		£	£
Brecon and Merthyr	1,910	1,876	1,885	1,928	1,930	2,065	2,070	2,026	3	6,161	+ 492
Cambrian	5,284	5,248	4,771	5,033	5,024	5,023	4,646	4,713	3	14,382	— 670
Central London	6,591	7,054	7,057	7,100	6,296	7,015	7,362	7,425	3	21,802	+ 591
City and South London	3,272	3,133	3,159	3,227	3,221	3,179	3,062	3,144	3	12,606	— 185
Furness	7,415	6,849	7,299	7,698	7,010	6,497	7,840	7,731	3	22,068	+ 222
Great Central	53,595	58,433	62,371	60,761	49,051	62,162	64,637	62,415	3	189,214	+ 7,649
Great Eastern	85,800	90,900	92,200	93,000	88,000	84,700	88,600	92,100	3	265,400	— 10,700
Great Northern	98,192	100,834	105,003	109,098	83,000	93,500	99,700	101,500	3	294,700	— 20,235
Great Western	195,600	203,000	201,700	206,500	179,900	203,300	209,000	201,600	3	613,900	+ 2,700
Hull and Barnsley	7,053	8,479	8,328	8,866	7,407	8,261	8,238	8,655	3	25,154	— 519
Isle of Wight	479	494	401	483	488	617	508	432	3	1,557	+ 229
Ditto Central	648	533	556	676	496	620	587	601	3	1,808	+ 43
Lancashire and Yorkshire	88,571	86,856	92,266	93,914	92,880	87,918	90,110	95,044	3	273,072	+ 36
Liverpool Overhead	1,563	1,598	1,569	1,497	1,483	1,505	1,480	1,451	4	5,869	— 358
London, Brighton, and South Coast	64,618	51,983	50,236	49,411	61,903	55,674	52,315	48,808	3	156,797	+ 5,157
London and North-Western	238,000	241,000	248,000	252,000	212,000	223,000	241,000	242,000	3	706,000	— 35,000
London and South-Western	81,700	73,800	75,600	71,600	78,400	72,600	77,100	72,700	3	222,400	+ 1,400
London, Tilbury, and Southend	8,027	7,455	7,377	7,075	8,920	7,352	7,927	7,418	3	22,697	+ 790
Maryport and Carlisle	2,138	2,079	1,870	1,869	2,142	2,090	1,990	2,059	3	6,139	+ 321
Mersey	1,465	1,570	1,569	1,596	1,731	1,664	1,480	1,619	3	4,926	+ 306
Metropolitan	17,502	17,316	17,266	17,268	17,638	17,377	17,369	17,382	3	52,128	+ 278
Ditto District	7,836	8,136	8,340	8,143	7,072	7,542	7,753	7,808	3	23,098	— 1,521
Midland	184,622	197,952	203,869	206,621	165,507	199,490	204,245	205,068	3	608,803	+ 361
North-Eastern	153,040	138,288	153,557	160,606	162,585	135,881	132,307	155,604	3	423,792	— 28,659
North London	9,912	10,382	10,347	10,265	8,138	9,501	9,581	9,337	3	28,369	— 2,625
North Staffordshire	18,752	16,465	16,929	18,034	17,189	14,986	16,026	16,309	3	16,309	— 4,157
South-Eastern and Chatham	78,897	82,239	74,270	73,733	77,755	85,689	75,040	75,150	3	228,587	+ 2,420
Taff Vale and Penarth	18,582	18,362	18,305	19,396	15,237	17,007	17,774	18,053	3	52,834	— 3,229
Caledonian	79,952	60,427	69,785	75,214	88,884	61,458	68,970	75,411	25	2,008,737	+ 10,724
Glasgow and South-Western	35,260	26,292	27,086	27,216	33,340	26,652	25,546	25,612	25	850,461	— 16,438
Glasgow District Subway	1,499	1,452	1,402	1,392	1,358	1,518	1,361	1,407	25	31,635	— 1,566
Great North of Scotland	10,368	8,846	8,514	8,384	9,232	8,978	8,310	7,978	25	240,098	— 3,286
Highland	8,665	7,464	7,774	7,975	7,671	7,308	7,084	6,744	25	253,761	— 4,095
North British	87,743	71,654	76,487	77,044	87,922	70,183	76,643	77,858	25	2,348,872	+ 18,811
Belfast and County Down	2,119	2,189	2,350	2,171	2,537	2,491	2,147	2,077	3	6,228	— 1,020
Cork and Bandon	921	1,744	1,462	1,459	1,326	1,120	1,248	1,239	3	3,607	— 1,057
Dublin, Wicklow, and Wexford	4,664	4,649	3,795	4,350	4,985	5,323	4,047	4,159	3	13,529	+ 735
Great Northern of Ireland	15,105	14,803	16,370	15,655	14,503	15,098	15,849	14,321	3	45,268	— 1,565
Great Southern and Western	18,192	20,332	21,863	20,936	20,886	22,190	19,951	19,752	3	61,893	— 1,243
Midland Great Western	10,348	9,377	9,443	9,641	9,714	8,210	8,798	9,836	3	26,844	— 4,027

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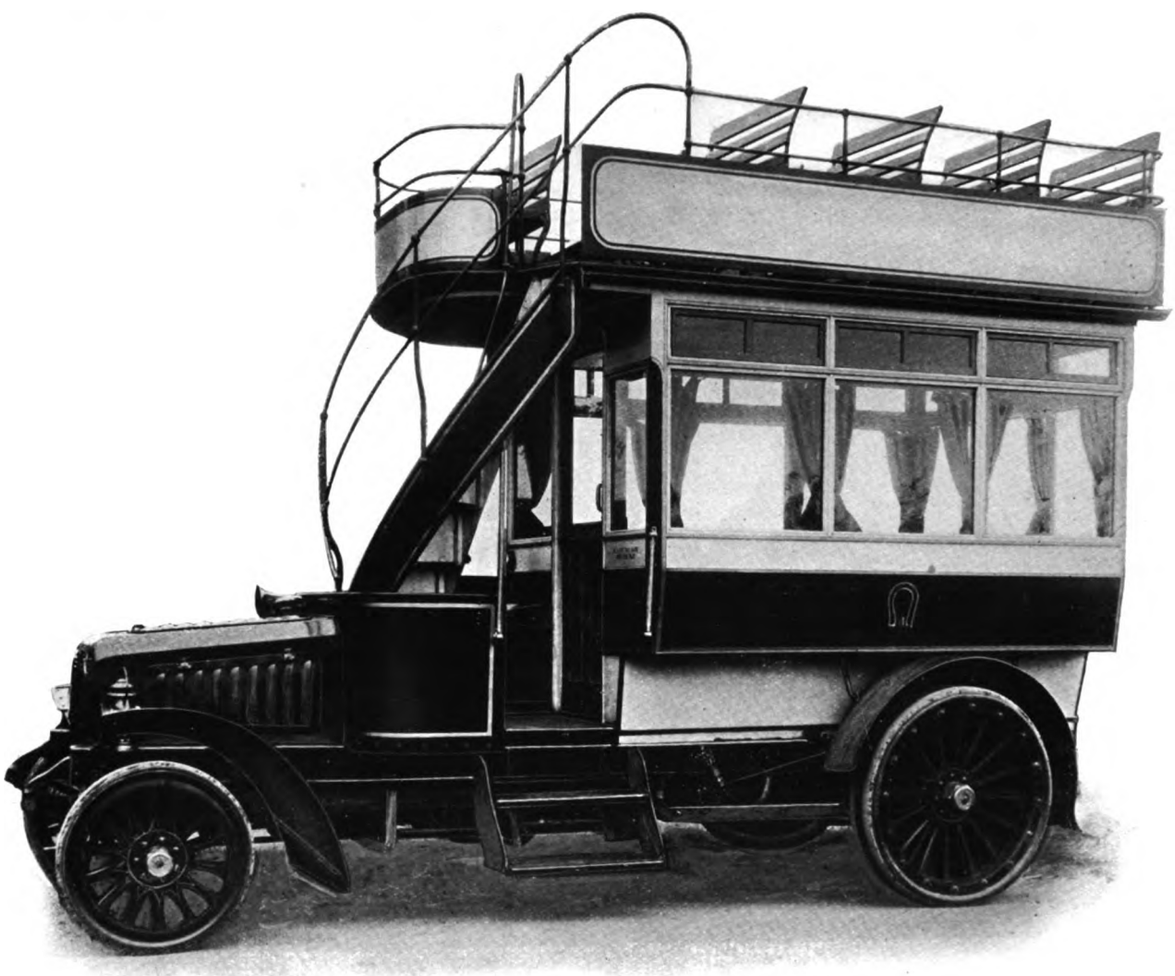
THE Tramway & Railway World
A REVIEW OF CURRENT PROGRESS IN ELECTRIC AND OTHER TRACTION

VOL. XVII. LONDON, MARCH 9, 1905. VOL. XVII.

TYPES OF MOTOR OMNIBUSES AT THE OLYMPIA EXHIBITION.

The great show of motor cars at Kensington, London, in the middle of February, gave the public an opportunity not only of inspecting a large variety of makes of luxurious private vehicles, but of seeing a number of automobiles designed for commercial purposes and for public service. The business vehicles included heavy lorries and lighter parcel vans, while the autocars for public service of course took the form of omnibuses. This was the first occasion on which any great variety of motor 'buses was exhibited, and though in comparison with the rest of the show the display was small, it was of very great interest to all concerned in the question of rapid local transit. In this article we do not propose to consider the comparative merits and economy of motor 'buses and tramways, but to describe some of the features of the new vehicles, and to quote such figures of cost as are available. The people concerned in all branches of the automobile industry have a wonderful faculty of attracting general notice, and this has recently been conspicuous in the efforts made in some quarters to spread the belief that the motor 'bus



Brush Company's One-Man Omnibus.

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is going to bring about a tramway collapse. This idea, erroneous as it is, no doubt added to the general interest in the omnibus exhibits, while tramway and omnibus men of course made minute examination. These latter recognise that whatever the future may bring forth there is now a prospect of having reliable motor 'buses, which may supersede horse 'buses, and may act as feeders to tramways in many districts.

We proceed to give some details as to the omnibuses which were exhibited. In general, it may be said, that they presented considerable similarity in appearance, and that, with the exception of one make using a steam instead of an oil engine, close inspection was necessary in order to reveal the differences in the machinery. The work of the past two or three years in connection with engines for pleasure cars has, to a considerable extent, standardised the general type of petrol engine for automobiles. Another general observation is that the whole of the vehicles exhibited were fitted with solid india-rubber tyres to the wheels. These ought to be more durable than pneumatic tyres, and at the speeds at which the omnibuses are designed to travel, they are expected to be quite efficient in deadening vibration. In most cases the back wheels had two tyres each, alongside of one another, the felloe of the wheel being made broad for the purpose. The double-tyre spreads the weight over a greater surface, while the two ridges with the hollow between tend to minimise side-slipping on greasy roads. The wheels themselves are of wood, very strongly built, and deeply "dished." The body of the omnibus is mounted on a steel rectangular frame which carries all the machinery, the axles, and the wheels. In tramway language this would be called a truck or underframe, but automobilism is nothing if not French, so the truck is called a châssis.

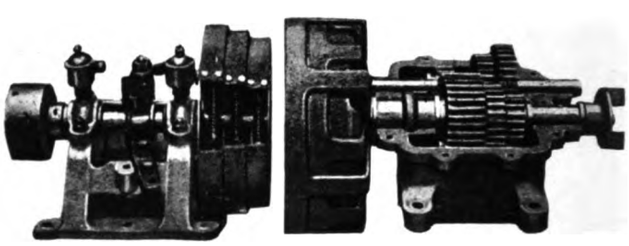
BRUSH COMPANY'S OMNIBUS.

The Brush Electrical Engineering Company, so well-known in the electric tramway and railway field, have now organised at their Loughborough works a department for the manufacture of motor omnibuses. Two of their vehicles were displayed at the show, one a complete double-decker for the Potteries Traction Company, and the other an omnibus body in the bare wood, for Birmingham. The Brush omnibus is arranged to be entirely under the control of one man, and it is provided with an automatic fare box. The seating accommodation is for 32 passengers. The timber used in the construction is rendered non-inflammable by chemical treatment, the Brush Company having installed a plant at their works for this purpose. In view of the suddenness of outbreaks of fire on motor cars, the Company attach great importance to the use of this non-flammable wood.

The one-man omnibus has been designed for service in sparsely populated districts in which only light traffic exists, but which may be linked with tramways and railways by means of motor omnibuses. The services of a conductor are dispensed with, so that the working costs may be kept down. The passengers enter by the driver's platform and place their fares in a box before taking their seats. The principal materials used in the body construction are seasoned English ash for the framing, mahogany and aluminium for the panels, and red deal for the flooring. The inside is framed and panelled in wainscot oak, and the seats are of perforated veneer. The windows are fixed in grooved rubber to prevent rattling. Ventilation is provided by means of hinged sashes over the side and end windows.

The engine is of the four-cylinder type, throttle-governed, with mechanically operated inlet and exhaust valves, and it runs at a maximum speed of 900 revolutions per minute, giving 30 brake horse-power. The bore of the cylinder is 110 mm. and the stroke 130 mm. An efficient silencer and water circulating pump are provided. High-tension or magneto ignition is used.

The special feature of the mechanism is the King patent gear, for which an exclusive manufacturing license has been secured by the company. The speeds are 14, 9½, and 4½ miles per hour, and a reverse at 3 miles per hour. The



King Variable Speed Gear for Brush Company's Omnibus.

steel gear wheels are accurately machined for noiseless running, and are always in mesh, thus avoiding all the wear and tear caused by forcing one gear wheel into another when changing speeds. It is further claimed for this gear that no jerking accompanies a change of the speed; that any omnibus driver can take charge of the vehicle after a few minutes' instruction, without any danger of his damaging the mechanism or losing control; that if both brakes were to fail, the omnibus would be able to descend the steepest gradient at walking pace on its lowest speed; and that the reverse may be left in operation while the car is running forward on the second and top speed, which is specially advantageous in crowded streets.

The gear consists essentially of a friction clutch, one end of which is coupled to the cardan shaft and the other end has three pairs of clutches in halves. Between the halves of each clutch is a pair of powerful springs which when expanded cause the clutch to grip tightly into its corresponding ring. Each of the three pairs of clutches has a roller mounted about the centre. The shaft containing the clutches is made hollow, and another shaft with indents

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corresponding with the rollers on the clutches is slid one way or the other by means of bobbins between the bearings and operated by the usual change-speed lever. The three sets of wheels in the gear box are always in mesh. At one end of the box the usual coupling is fixed to the foot clutch connected to the engine; the other end has three external drums each running at different speeds in proportion to the gear wheels mounted on their respective shafts, the two outer shafts being hollow to admit of their being driven separately. The inner shaft is solid and has the smallest or inner drum connected to it, so that when the small clutch is expanded to grip the small outer drum, the drive is straight through from the engine to the cardan shaft, but as the medium or larger clutches are expanded into their respective outer clutches, the drive is effected through the small wheel on the high speed shaft and through the centre shaft back again to the respective outer clutches in proportion to the ratio of the wheels.

Single-Deck Clarkson Steam Omnibus.

CLARKSON'S STEAM OMNIBUS.

The form of motor omnibus made by Clarkson, Limited, Chelmsford, which was on view at the show, differs from all the others in respect that it is driven by a steam engine instead of a petrol engine. The vehicles of this firm include a 32 H.P. double-deck 'bus to carry 32 passengers, which has been built for the London Road Car Company, and a 32 H.P. country-service, steam-warmed 'bus to carry 18 passengers and 15 cwt. of luggage, built for the London and South Western Railway Company. We also give an illustration of a single-deck 'bus supplied to the London General Omnibus Company. Various advantages are claimed for the steam motor, and undoubtedly it has many ingenious and valuable features. The most obvious advantages to the outside public are the absence of smell and noise, while owing to the use of heavy oil no inflammable vapour is produced, so that the risk of fire is minimised. The burner which takes the place of the furnace in an ordinary steam boiler is capable of burning any grade of mineral oil from crude petroleum upwards. The oil is really vapourised before it reaches the combustion nozzle. This is effected by the flame being spread out in the form of an inverted cone and by the supply pipe being led round in a circle in the flame. The burner is started by a pilot light which is easily accessible from the side of the car. The burner is also entirely automatic in its action, as it is shut down gradually as the pressure of the steam increases. The oil is forced from the oil tank under a pressure of 35 to 40 lb. per square inch, which is maintained by a feed pump. The burner is enclosed in a sheet-steel box lined with nickel and asbestos. It is placed below the boiler, which has a shell of mild steel. This boiler is of the water-tube type, and the tubes, which really form an endless pipe, are arranged so as to form a sort of a square gridiron with a side of about 30 in., and a depth of about a foot. The tubes are of weldless steel, half an inch in diameter, and expanded in top and bottom plates. Each boiler is tested by haudraulic pressure to 750 lbs. per square inch, and by steam to 450 lbs. per square inch. It is fitted with twin safety valves to blow off at 400 lbs., and there is an automatic regulator to control the burner, and a water gauge. The water is fed in at the top, and the circulation is so rapid that there is no trouble from lime deposit. By the time that the water gets half-way down in its circulation, it is practically all changed into steam, and in the lower tiers of the tubes it is dried and superheated.

The engine, which is double acting, has two cylinders, 4 in. by 4 in., placed horizontally. For

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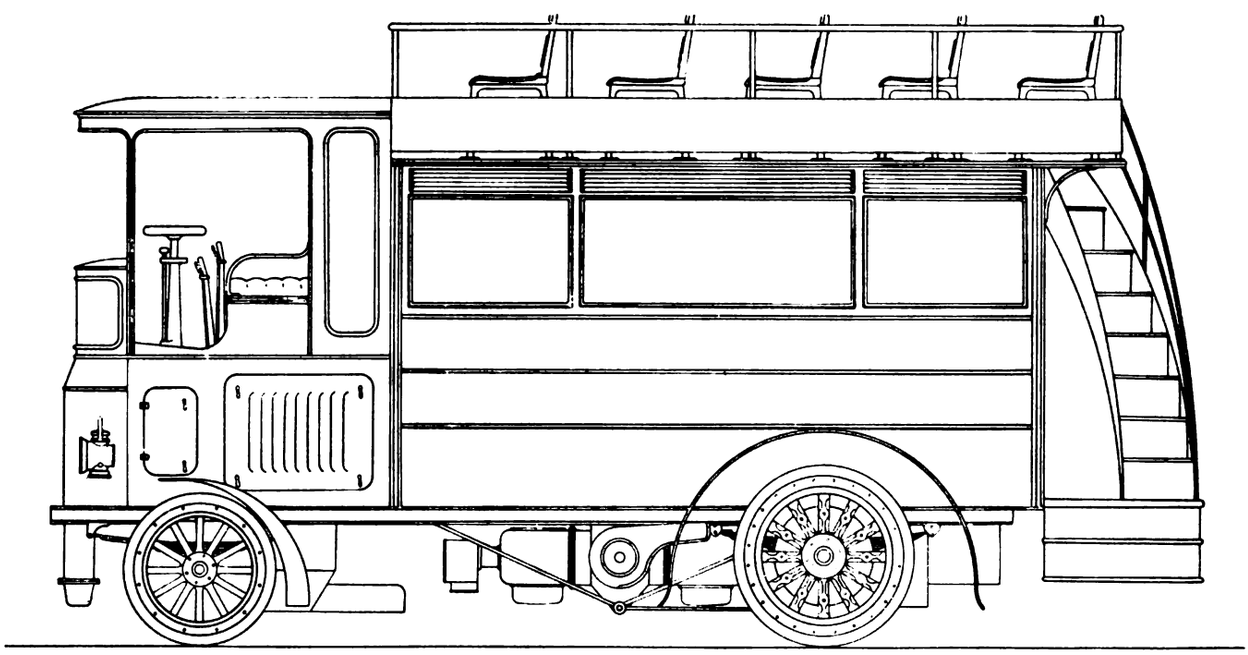
a double-deck omnibus two engines are provided, one in front of the other, each of nearly 20 H.P. The valves are actuated by Joy's gear, and there are all the ordinary appurtenances of a steam engine packed away in wonderfully small space. The crank shaft is of forged steel, bored hollow. The engine is enclosed in a cast aluminium case, with removable panels for inspection. It drives on to a bronze gear ring encircling the differential gear box. The six gear wheels are of phosphor bronze, cut out of the solid, and working on hollow steel pins. The lubrication is forced by a pump into all the bearings in succession by the action of Clarkson's patent distributer. Another pump provides for the cylinder lubrication. There are in all five pumps fitted underneath the omnibus. The exhaust steam is condensed in two condensers. The power is communicated from the differential shaft to the driving wheels by chains.



Elevation of Clarkson's Double-Deck Steam 'Bus.

The wheels are 34 in. in diameter, artillery pattern, with steel hubs, oak spokes, and ash felloes; either iron or indiarubber tyres are provided as required. There are two independent brakes, an outer band brake worked by a foot lever, and an inner band brake worked by hand and capable of locking.

The price of the single deck 'bus is £826, and that of the double decker from £900 to £950, according to the design and finish of the body. The following figures, quoted by Messrs. Clarkson, of running costs per 'bus mile, are of interest.

Fuel, paraffin (London Road Car Company's experience)	·93d.
Lubrication (patent automatic system)	·16d.
Tyres	1·38d.
Depreciation at 15 per cent.	·95d.
	3·42d.

These figures, of course, include nothing for repairs and wages, nor for the usual general charges, adminstration, rates and taxes, and so forth connected with a large undertaking. The Torquay Motor Omnibus Company, who use the Chelmsford 'buses exclusively, have had a fairly successful year, but the cost for repairs will no doubt rise as time goes on. The directors of the Company declined to inform the shareholders what the receipts and expenses per mile run are. It appears, however, that the traffic receipts for the year totalled £2,290, and that the gross balance was £355. The advantage of a small capital, however, then came in, and a dividend of 7½ per cent. was declared. The chairman of the Company stated that the india-rubber tyres on the back wheels of a 'bus would last for about 10,000 miles, while those on the front wheels would run about 15,000 miles. To renew the back wheel tyres cost £50, while a new set for the front wheels cost £25. It may be mentioned that the tyre-making firms are prepared to maintain solid rubber omnibus tyres at a charge of about 2d. per mile run.

MAUDSLAY 'BUS.

A specimen of a single-deck 'bus, built by the Maudslay Motor Company, Limited, Parkside Works, Coventry, was on view at the show. This type has been built for the Great Western Railway Company, and is intended for service in rural districts. It carries from 12 to 14 passengers, and is propelled at speeds up to 12 miles an hour by a 14 brake horse-power, two-cylinder, petrol engine. The gear provides for four speeds and a reverse. The brakes are worked by hand and by foot pedal, and are applied to the back wheels and to the countershaft. There is a big speed reduction in the gear-box, so as to allow of the use of large sprocket chain wheels. This

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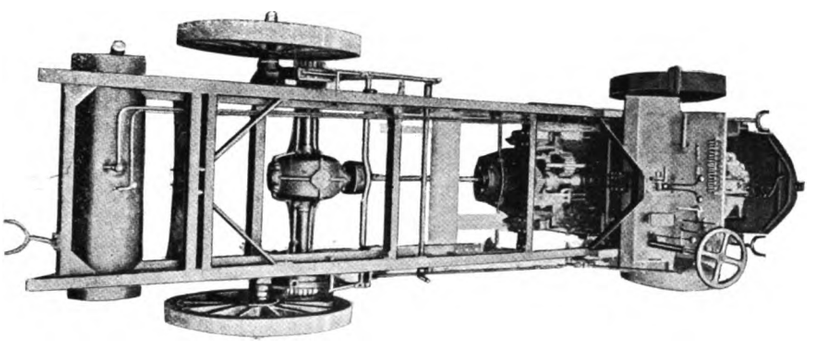
omnibus is listed at the comparatively low price of £575, and it appears to be a serviceable vehicle.

MILNES-DAIMLER OMNIBUS.

Milnes - Daimler, Limited, 221, Tottenham Court Road, London, were among the earliest of the firms to devote special attention to the development of the petrol engine to omnibuses, and their efforts are now being rewarded, as their motor and chassis are now very favourably regarded by the omnibus companies, and they have orders from the London General Omnibus Company, Thomas Tilling, Limited, the Atlas and Waterloo Omnibus Association, and others. They have also been very successful in meeting the wants of the railway companies for motor 'buses, and the vehicles they had on view at the show included several different types constructed for the Great Western Railway Company.

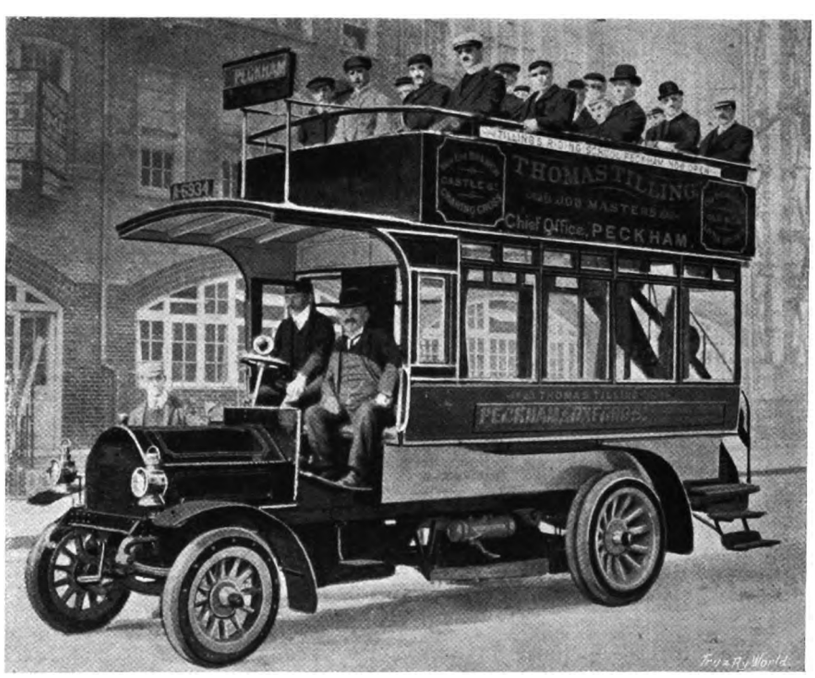


View from above of Milnes-Daimler Omnibus Chassis.

The engine employed for a double-deck 'bus seating 34 passengers is a 4-cylinder one, developing 22 brake horse-power at 800 revolutions per minute. The power can be raised to 25, with the speed increased to 1,000 revolutions per minute. The cylinders have a bore of 105 mm., and the stroke is 130 mm. The gear allows of speeds of 2½, 4½, 6, and 12 miles an hour. A slightly less powerful engine is made for single-deck 'buses, with gear providing for speeds of 3, 6, 9, and 15 miles an hour. Various other sizes and powers of engines are made for different purposes. The petrol tank on the chassis holds 16 gallons, and the consumption is about a gallon per hour.

The main frame of the chassis is built of strong steel girders. The axles are steel forgings. The engine and gear box are carried on an under frame of angle-steel members. Two wooden beams forming radius rods are fixed to the back axle. These relieve the springs of strains due to the driving mechanism, and absorb any sudden shocks. Fixed to the rods is a casing containing the countershaft, the bevel wheels of that shaft, and the differential gear. Each half of the countershaft carries a spur-wheel outside the casing, and these spur-wheels mesh with internal gear-rings that are bolted to the road wheels. The shafts run in ball bearings. The differential gear is mounted on the rear end of the longitudinal shaft, instead of on the countershaft. The differential gear thus runs at a higher speed and is less liable to strain. The fly-wheel of the engine and the clutch-cone are constructed with fan blades, so that they draw air through the honeycomb radiator.

As to the gear, the first motion shaft carries sliding spur wheels, and the second motion shaft is immediately beneath it. The four sliding wheels are grouped in pairs, each of which is operated by a separate hand lever. A powerful brake is mounted on the front end of the second motion shaft, and this is worked by a pedal which also controls the clutch. When this pedal is partly depressed it disengages the clutch, but does not begin to apply the brake, so that the engine is then free to run without driving the first motion shaft. The pedal can be locked in this position when the vehicle is at rest. Two other brakes, simultaneously operated by a second pedal, are mounted on the ends of the countershaft. In addition tyre brakes can be applied to the back wheels by a hand lever.



Milnes-Daimler Double-Deck Omnibus.

In addition to the petrol carburetter, a second one is fitted for use when the engine is using ordinary lamp oil. This second carburetter has

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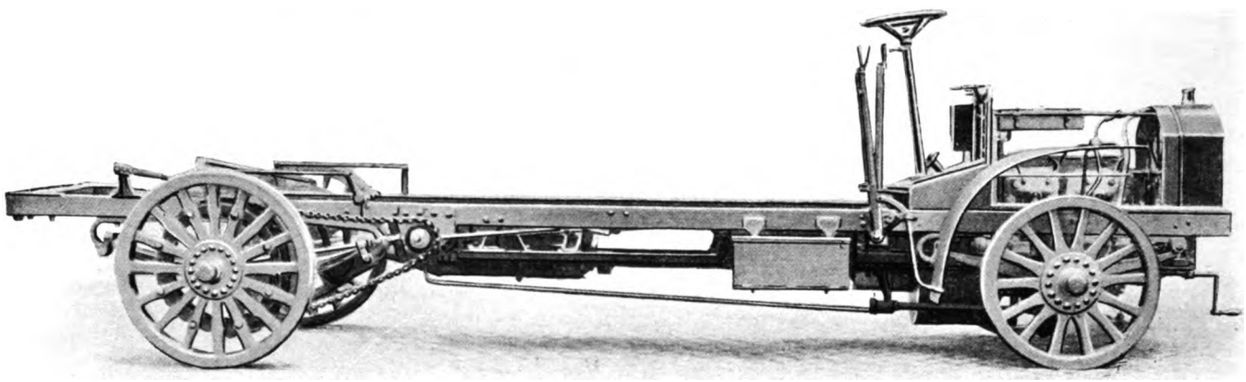
its mixing chamber heated by the exhaust gases, which pass through a jacket. Petrol must, however, be used for starting, so that the kerosene carburetter may be warmed up before the heavier oil supply is turned on.

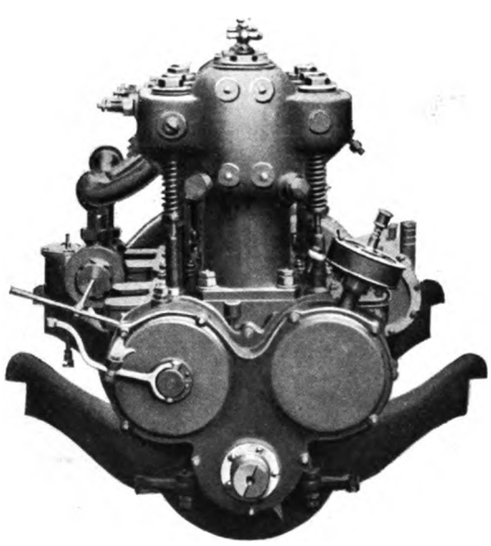
MOTOR CAR EMPORIUM 'BUS.

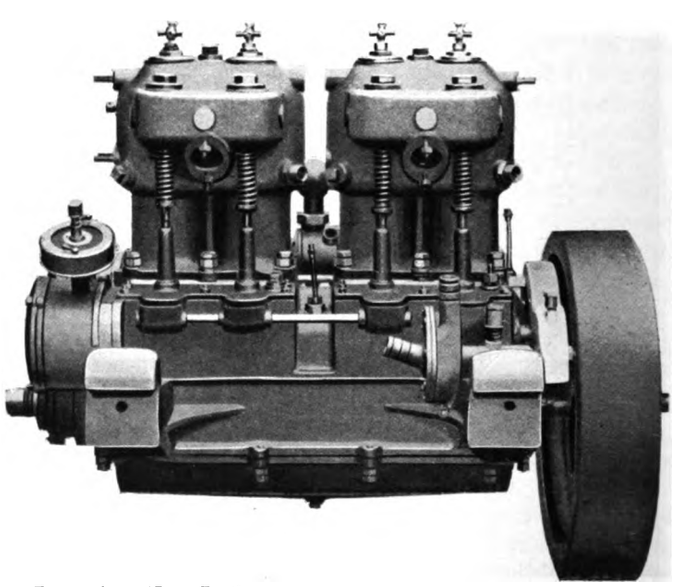
The Motor Car Emporium, Limited, Addison Road North, Holland Park, London, W., had two 'buses on view at the show, one a single-decker to seat 16 passengers, fitted with a four-cylinder 20 H.P. engine, and the other a double-decker, to carry 36 passengers, with a four-cylinder 24 H.P. engine. Of the latter type of 'bus, the London Road Company have ordered 51, and it is also in use by the Hastings and St. Leonards Omnibus Company. The makers provide a great variety of motor vans, etc., and a proof of the reliability of their engines is given in a daily record for a whole year of a Post Office parcel mail van running between London and Redhill. During the period this van almost always arrived ahead of schedule time. The amount paid for repairs and renewals in the twelve months was under £15, and the average petrol consumption worked out at one gallon per 11 miles.

The four-cylinder engine for omnibuses is of the vertical type, and the exhaust and inlet valves are interchangeable. The carburetter is connected with the governor, which automatically regulates the supply of gas to the engine by means of a throttle valve. Besides this, there is a variable cam fitted to the inlet, by means of which not only can the stroke of the inlet valve be varied, but also the time of lifting. By this means the speed of the engine can be varied between 120 and 1,000 revolutions per minute. The circulating water is driven by a rotary pump, and the water is cooled by a fan. The power transmission is through a large clutch, and the gear provides for three speeds and a reverse. The gear wheels, contained in an oil-tight case, are large and are polished before hardening. Roller and ball bearings are used on the principal parts of the engine and gear, and forced lubrication is employed. The petrol tank is specially designed to prevent explosion, and it carries a charge sufficient to run the omnibus 100 miles. Special attention has been paid to the question of springs, so that vibration is minimised. There are three brakes, one a foot brake actuating a band on a drum, and the others hand lever brakes applied to the rear wheels. The driving clutch



Motor Car Emporium Omnibus Chassis.





Views of Motor Car Emporium 'Bus Engine.

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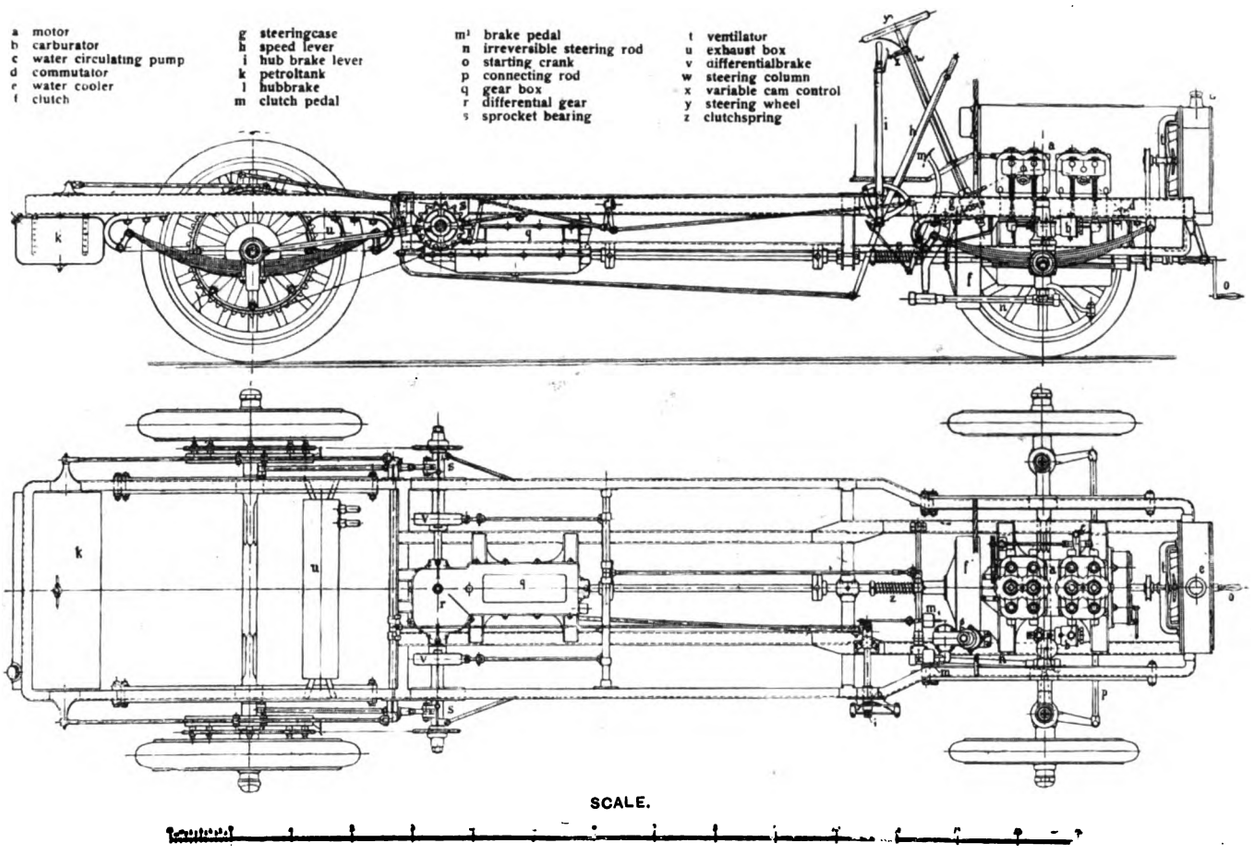
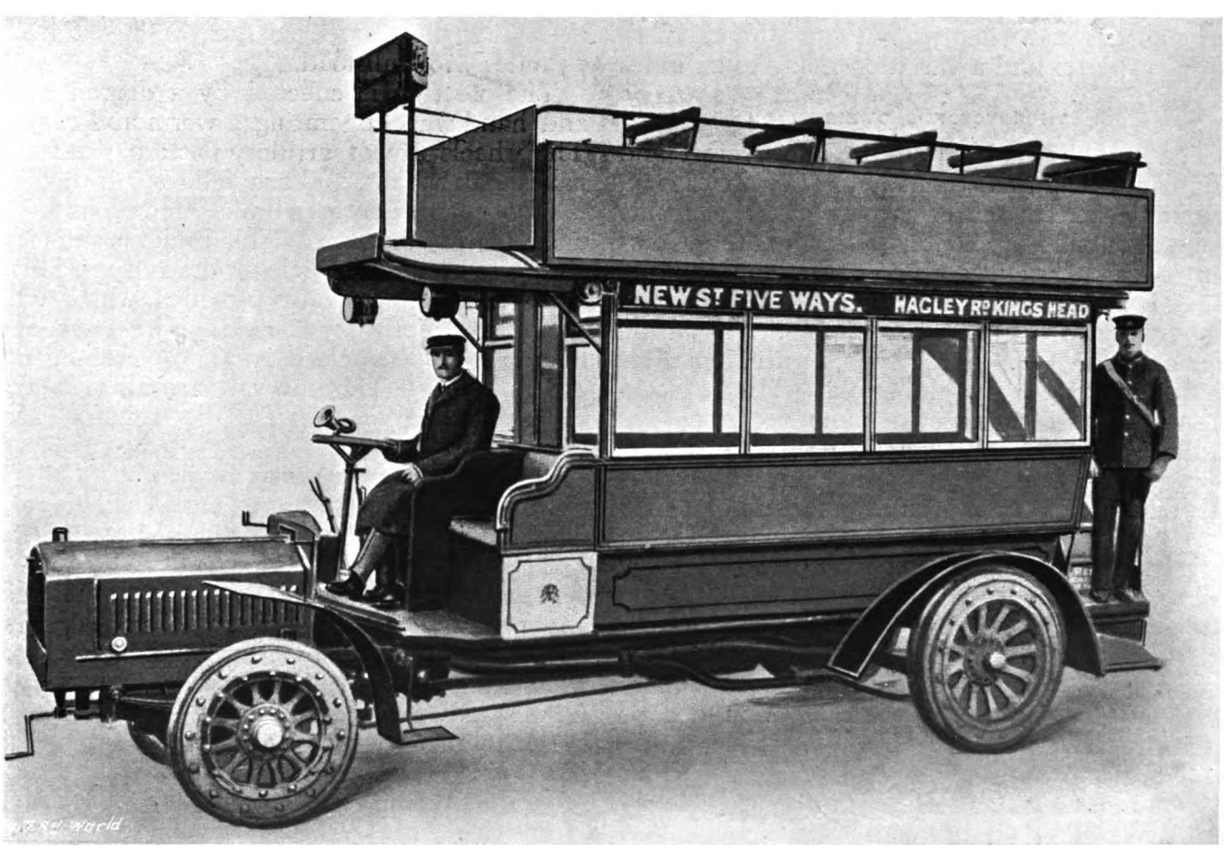


Elevation and Plan of Motor Car Emporium's 'Bus Chassis.



Motor Car Emporium's Double-Deck Omnibus.

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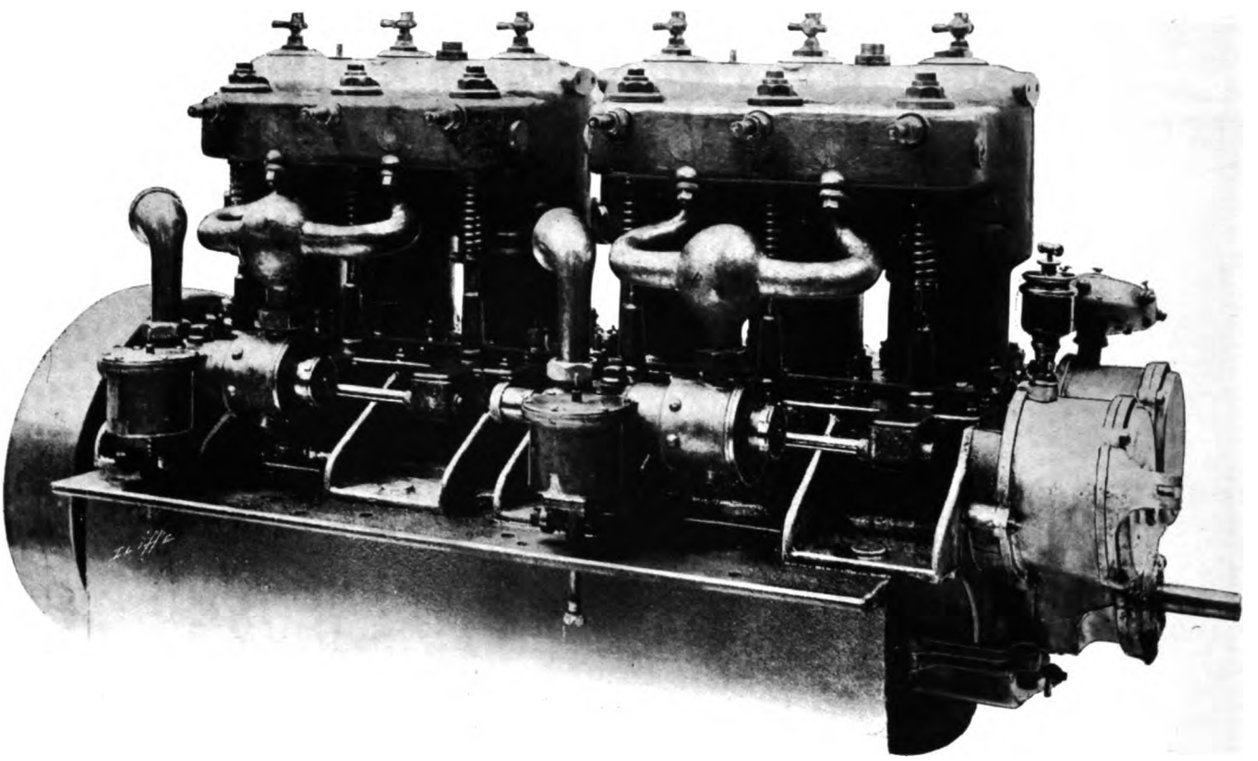
is disconnected automatically when the brakes are applied.

One of our illustrations shows a six-cylinder engine by the same makers designed for tram-



Motor Car Emporium's Six-Cylinder Engine for Tramway Car.

way cars. It is of 40 H.P., and the consumption of petrol is figured out at about 20 miles to the gallon. The bearings are of large diameter, and the engine works silently and smoothly. There are two speeds, and a variation rising to 24 miles an hour.

THORNYCROFT'S OMNIBUS.

The 'bus shown by John I. Thornycroft and Company, Limited, Chiswick, London, is a double-decker seated for 34 passengers, 16 inside and 18 outside. The chassis is of the Company's own design and construction, and its general arrangement may be seen from the accompanying drawings. The engine is of the four-cylinder Otto-cycle type, with cylinders 4¼ in. in diameter, by 5 in. stroke. Under working conditions, running at 900 revolutions per minute, the engine develops 24 brake horse-power. The average 'bus speed on the level is about 10 miles an hour, and gradients of 1 in 8 can be climbed. The whole engine and cam gear are enclosed in an oil-tight dust-proof case, and forced lubrication is provided for all moving parts. The cylinders are cooled by water circulation, operated by a pump of the rotary gear type. The ignition is of the low-tension magneto type, but high-tension electric ignition can be fitted if required.

A change-speed gear is fitted, giving four different speeds. By this gear the omnibus may be driven at 3, 5½, 8½, or 12 miles per hour. The gear also allows of a reverse speed of 3 miles per hour, this being used when it is desirable from any cause to back the omnibus. It is also possible to accelerate the engine, so that a maximum forward speed of 15 miles an hour may be attained. All the gear rings are of hardened mild steel, and are enclosed in a dust-proof and oil-retaining gear case. Sufficient petrol can be carried to run the 'bus for about 75 miles with full load.

The steering is effected by a diagonal shaft and hand wheel operating a worm and segment. The wheels are of artillery pattern, with metal naves, oak spokes, and ash felloes. A pedal on the foot-plate operates a brake on the countershaft close to the gear box. This brake is sufficiently strong to hold the vehicle on the steepest hills. A screw-down brake is also provided, which acts on the drum of the back axle. The price of an omnibus of this class is £900. Among other orders, Messrs. Thorneycroft are now constructing 22 of their chassis for the London Motor Omnibus Company.

STRAKER-SQUIRE OMNIBUS.

Public attention was recently called to the machine put on the market by Messrs. Straker and Squire, 9, Bush Lane, London, E.C., by the successful carrying out of a 2,000 miles reliability trial on public roads. The vehicle employed was not an omnibus, but though its appearance somewhat resembled that of a private motor car, it was loaded to the ordinary extent of a 'bus, and the machinery was that employed for omnibus purposes. The engines and other apparatus required have hitherto been built by Büssing, of Brunswick, but Messrs. Straker and Squire are now preparing to construct them in this country.

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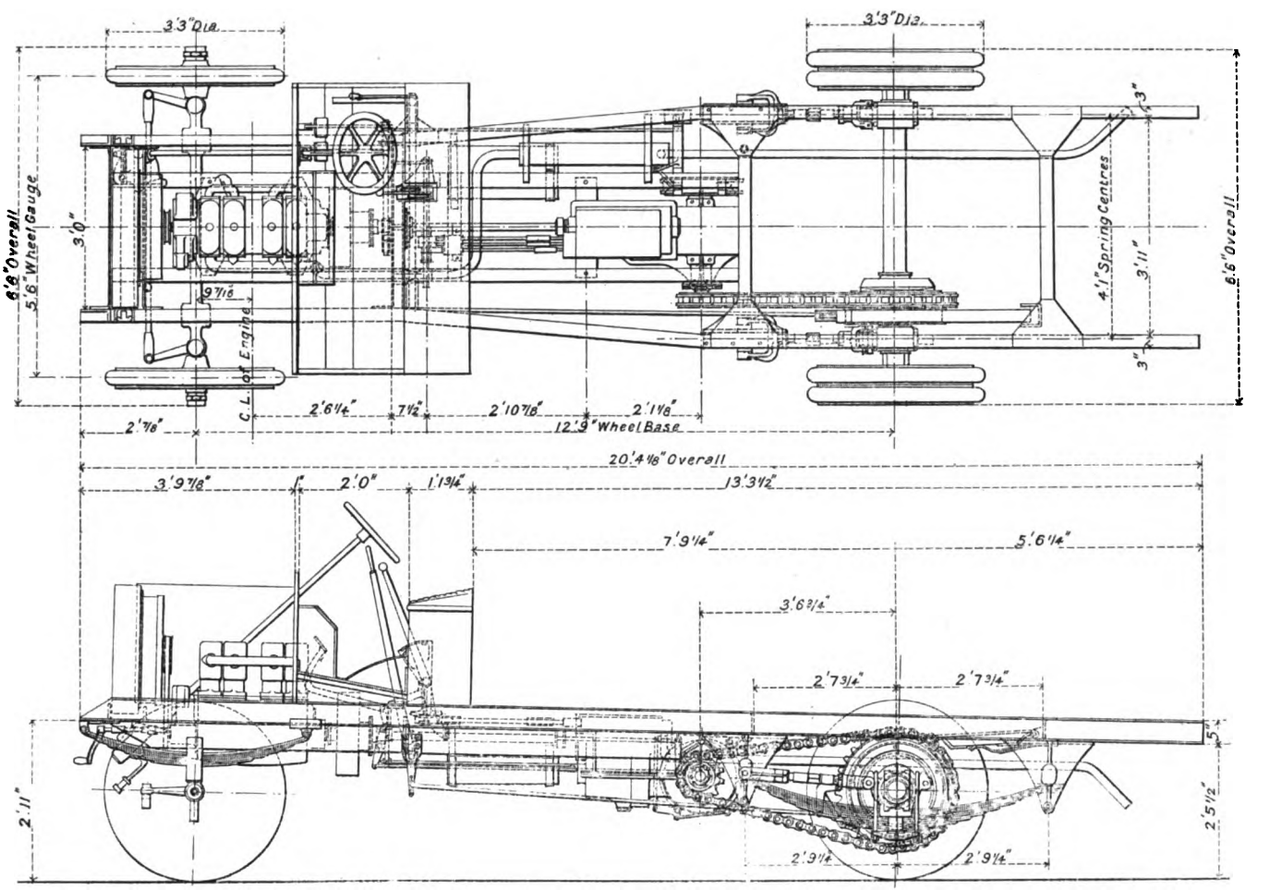
The illustrations show the appearance of a 'bus and its appliances.

Minute details of the engine, transmission gear, etc., have been issued by Messrs. Straker and Squire, but the following general description will here suffice, particularly as a method of transmission of power from the engine to a countershaft and thence by variable gearing to the driving wheels is more or less common to all such vehicles.

The petrol engine is a four cylinder one of 24 H.P., and the transmission is by a clutch through a change-speed box immediately in rear of the engine, and thence to a second change-speed box situated in front of the back axle. This engine is designed either for a 'bus accommodating 36 passengers, or for goods vehicles up to 4 tons in weight when loaded. The principal feature of the engine consists in the placing of the cam-shaft, which actuates the inlet and exhaust valves as well as the ignition tappets, on the top of the cylinders. The inlet and exhaust valves are arranged on opposite sides of the cylinders, and the actuating shaft is driven off the crank shaft. The arrangement ensures great certainty of action, and the mechanism is well removed from the dust of the road. The cam-shaft with rollers and rocking levers runs in an oil-bath. Doors on each side of the crank chamber allow of access to the connecting rods and crank-shaft. The cylinders are cast in pairs, and the water jacket is so arranged that not only the explosion chambers of the cylinders, but also the valve chambers are completely surrounded. The crank chamber, which is formed of two aluminium castings, provides three extra long bearings for the shaft. In order to diminish the weight of the reciprocating parts and thus reduce vibration, the connecting rods are hollow and made of nickel-steel, and are unusually long. This in conjunction with the length of the pistons gives great smoothness in running. The crank-shaft also is of forged nickel-steel. The carburetter is of the jet type, and the fuel tank can hold 20 gallons. The petrol consumption is about one gallon per eight miles. The throttle, besides being acted upon by a governor, can also be controlled by the driver of the 'bus, so that the engine speed may be varied from 200 to 900 revolutions per minute. The low-tension magneto igniter and the centrifugal pump for the water circulation are driven from the crank shaft. The cooling of the water in the radiator is aided by a fan mounted on the crank-shaft.



Thorneycroft 'Bus.—Plan and Elevation of Chassis for 34-Passenger Vehicle.

In regard to the transmission gear, there are three changes of speed and one reverse provided for in the front gear-box, while in the rear gear-box, which contains the countershaft and differential gear, there is a gear-ratio change on a third-motion shaft, which in its turn drives by chains on to the back axle. The change of speed

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is effected by levers, and by actuating the gear change in the rear box the three speeds provided for in the front box can be doubled or halved. There are accordingly six speeds available, approximately as follow: High ratio, 3, 9, or 14 miles per hour; low ratio, 1½, 4½, or 7 miles per hour. The gear-wheels, which are made of Siemens-Martin steel, machine-cut and deeply hardened, run in oil-proof casings. The back axle is fitted with a spring radius rod attachment, for the purpose of eliminating shock when starting and when changing speeds.

The omnibus on view at the show was built for the London Road Car Company, and the firm have supplied others to the London General Omnibus Company, and to Thomas Tilling, Limited. Views of the Road Car Company's 'bus and chassis are here given, together with drawings of the chassis and lettered views of the engine. The names of the parts are set out in the reference table given below.

We are indebted to Messrs. Straker and Squire for the following interesting financial details as to the results attained on the 2,000-mile reliability trial (already referred to) of one of their cars. The car was loaded so as to represent the weight of an omnibus three-quarters full of passengers. The petrol consumed for the 2,000 miles was 298 gallons, which is approximately equal to 7 miles to 1 gallon. The petrol cost wholesale about 7d. per gallon, so the cost of fuel was about 1d. per omnibus mile.

The tyres with which the vehicle was fitted were guaranteed by the makers for 2d. per car mile, on the basis of running 100 miles a day, which was the daily run during the trial.

Ordinary omnibus work would necessitate the employment of two drivers and two conductors. Taking the drivers' wages at £2 each per week, and the conductors' wages at £1 5s. each per week, the total wages would be £6 10s. per week, or £19 10s. for the whole 2,000 miles. This is equal to rather less than 2½d. per car mile.

The lubricating oil consumed was at the rate of about one gallon per day, equal to about ¼d. per car mile.

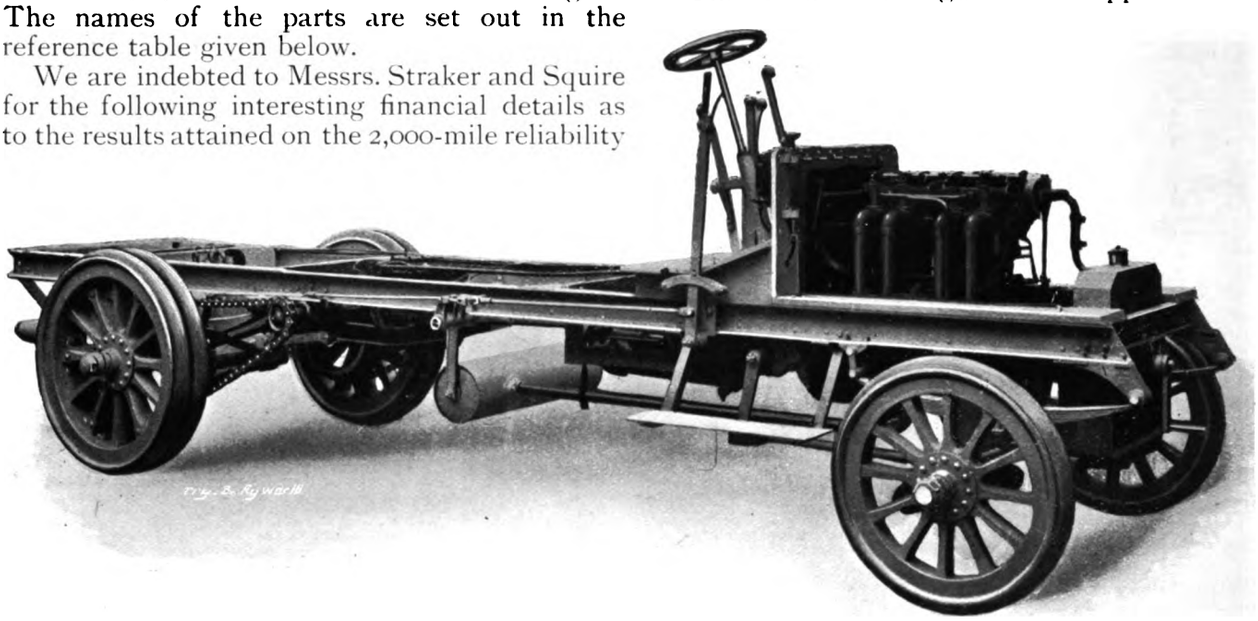
The repairs were calculated on a basis of £30 per annum, spread over a number of years. This is equal to rather less than ¼d. per car mile.

As it is generally considered desirable to write off the value of motor cars as rapidly as possible, independent of their actual depreciation, an allowance of 20 per cent. per annum was made for depreciation. Taking the cost price of the omnibus at £900, this would be £180 per annum, equal to about 1¼d. per car mile.

The shedding, rent, cleaning and insurance should, the makers consider, be covered by about £60 per 'bus per annum, which is equal to about ½d. per car mile.

Totalling these items, which in the makers' opinion form a liberal estimate, the cost of running works out at about 7½d. per car mile, with a vehicle actually carrying about 24 passengers.

This is a lower figure than appears to be anticipated in many quarters, and, of course, if it is attained in practice, the builders will deserve warm congratulations. It does not, however, include, apparently, a good many minor items which appear in the accounts of large tramway and omnibus concerns, while, apart from that, the test of time is required to prove whether the items, which are mentioned, are approximately correct. Taking the figures, however, as they stand, two things have to be borne in mind in comparing them with the working expenses of horse omnibuses on the one hand and electric tramway cars on the other. The one is that the



Straker-Squire Omnibus Chassis.

REFERENCE LETTERS FOR ILLUSTRATIONS.

A	Manholes in cylinder heads.	B3	Induction pipe.
A1	Oil scoops on connecting rods.	B4	Carburettor float-feed chamber.
A2	Spiral gear wheel driving cam-shaft.	B5	Main air supply pipe.
A3	Spur-wheel driving magneto and pump.	B6	Cold air regulator.
A4	Inspection doors in crank-chamber.	B7	Accelerator lever.
A5	Half-compress on cocks.	C	Exhaust valves.
B	Inlet-valves.	C1	Rocking levers operating same.
B1	Rocking levers operating same.	C2	Yokes for inspection plugs.
B2	Yokes for inspection plugs.	C3	Exhaust pipes.
		C4	Expansion chamber.

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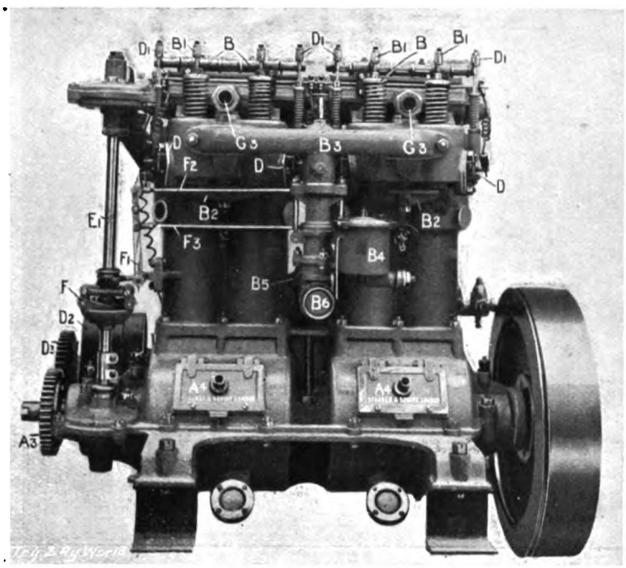
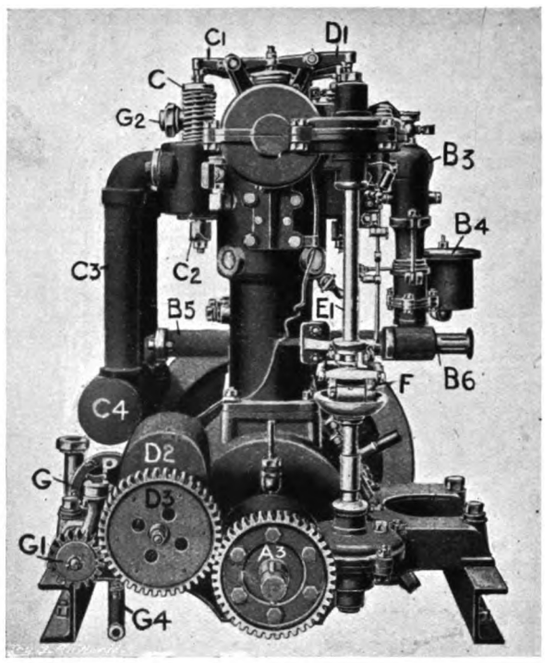
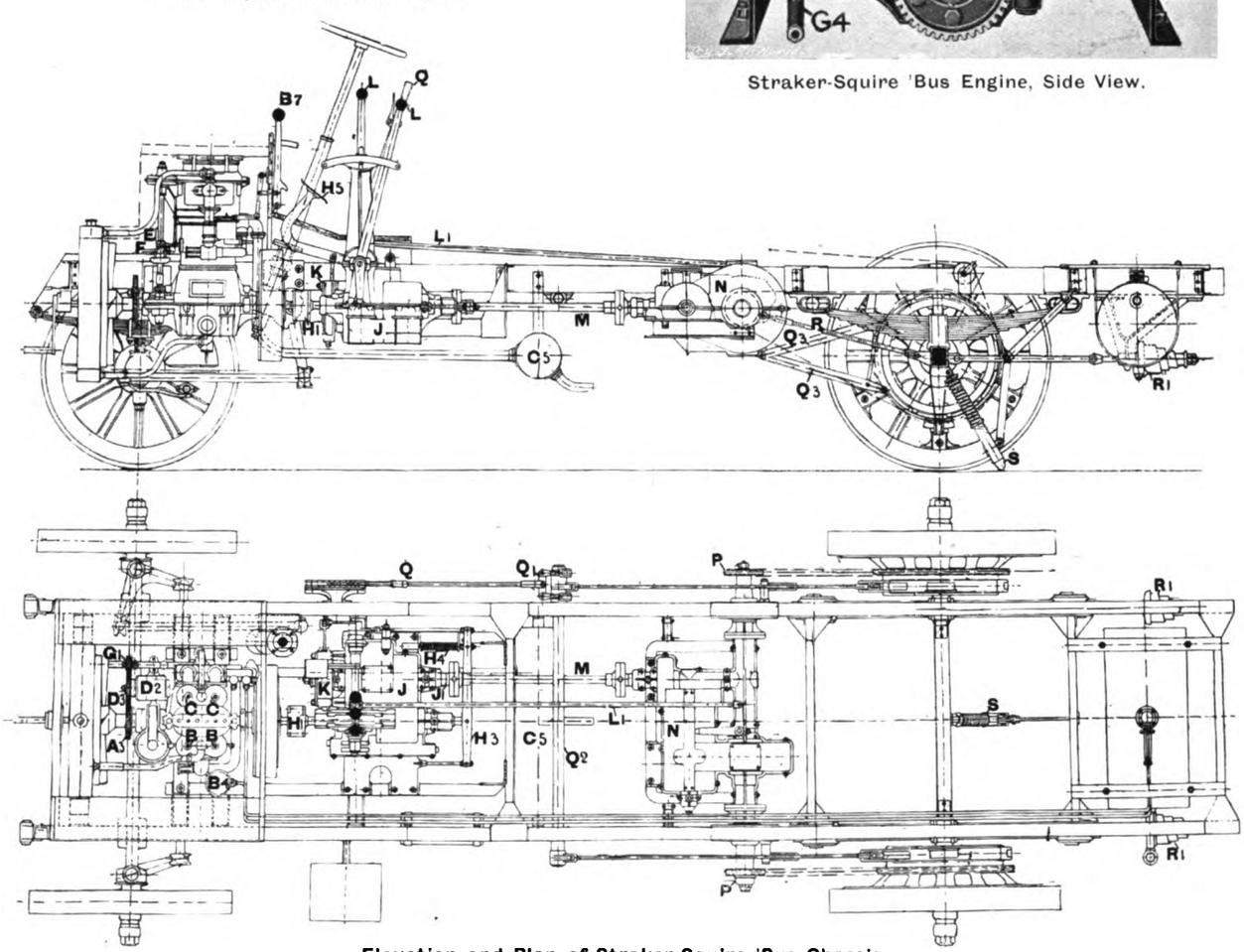


Straker-Squire Omnibus Engine.



Straker-Squire 'Bus Engine, Side View.



Elevation and Plan of Straker-Squire 'Bus Chassis.

C5 Exhaust box.
D Low-tension igniters.
D1 Rocking levers operating same.
D2 Magneto.
D3 Spur-wheel on magneto shaft.
E Cam-shaft.
E1 Vertical shaft driving shaft E.
E2 Ball-thrust-bearing for shaft E1.
F Governor.
F1 Bell crank lever.
F2 Rod operating throttle-valve.
F3 Rod operating air-valve.
G Circulating pump.
G1 Spur-wheel on pump shaft.
G2 Delivery pipe to cylinders.
G3 Return pipe connection.
G4 Suction pipe.
H Clutch cone.
H1 Coupling in same.
H2 First-motion shaft.
H3 Pivoted clutch lever.
H4 Clutch spring.
H5 Clutch pedal.
H6 1st speed and "reverse" pinion.
H7 2nd speed: spur-wheel.
H8 3rd speed: spur-wheel.
H9 Rod connecting pedal with clutch.
J Three-speed gear-box.
J1 Second-motion shaft.
J2 "Reverse" spur-wheels.
J3 1st speed spur-wheel.
J4 2nd speed spur-wheel.
J5 3rd speed spur-wheel.
K Brake-drum on second-motion shaft.
L Change-speed levers.
L1 Rod operating second-gear box.
L2 1st and "reverse" speed operating bar.
L3 2nd and 3rd speed operating bar.
L4 Striking fork for second gear-box.
M Propeller shaft.
N Combined gear-box and differential casing.
N1 Longitudinal shaft in second gear-box.
N2 Bevel-wheel on shaft, N1.
N3 Thrust bearing on shaft, N1.
N4 Bevel-wheel on intermediate shaft, N5.
N5 Intermediate transverse shaft.
N6 Low-speed spur-wheel on shaft, N5.
N7 High-speed spur-wheel on shaft, N5.
N8 Underframe carrying gear-box, N.
N9 Swinging links supporting N8.
P Sprockets on countershaft.
P1 Differential countershaft.
P2 Differential sleeve on same.
P3 Low speed spur-wheel on differential shell.
P4 High-speed spur-wheel on differential shell.
P5 Differential gear.
Q Brake-lever.
Q1 Compensating link.
Q2 Rock-shaft.
Q3 Anchor rods.
R Radius rods.
R1 Cushion springs.
S Sprags.

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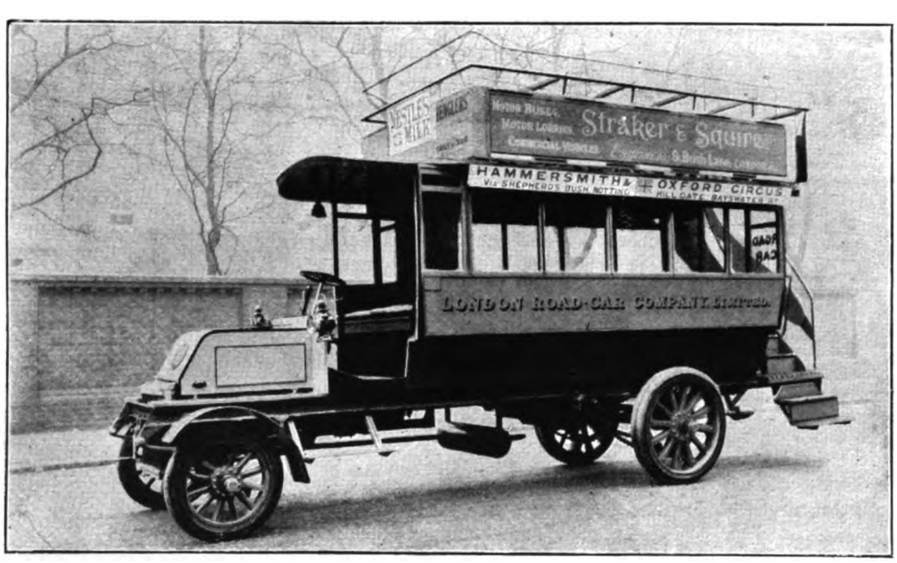
motor 'bus seats some six or eight more passengers than the horse 'bus, and, therefore, its receipts will be higher than those of the horse 'bus. The other is that the motor 'bus seats only about half the number of people that an electric tramcar provides accommodation for, so that its receipts will be much lower than those of the electric tramcar.

WOLSELEY OMNIBUS.

The Wolseley Tool and Motor Car Company, Limited, Adderley Park, Birmingham, exhibited a Great Western Railway omnibus at the show. The accompanying illustrations display many of the details of the vehicles which the Company are constructing for road work; their rail motor cars have previously been described in our pages. Their 20 H.P. two-ton chassis is designed to meet the demand for a vehicle of substantial construction having a very large carrying capacity. The horizontal position of the motor enables the dashboard to be carried very far forward, thus rendering a large portion of the chassis available for body space. The maximum allowable load is three tons. The frame which is composed of steel channels is 3 ft. 10 in. wide. The length from the dashboard to the end of the frame is 16 ft. 6 in., but the body can conveniently overhang the frame by 18 in., thus allowing of a body 18 ft. long overall. The overhang of frame behind the rear axle is 4 ft. 6 in. The height of the top of the frame from the ground is 31 in. The wheel-base is 12 ft., and the track 6 ft. 2 in., the overall width coming inside the 7 ft. 2 in. limit. The total length of the chassis is 18 ft. 6 in., and the weight about 48 cwt.

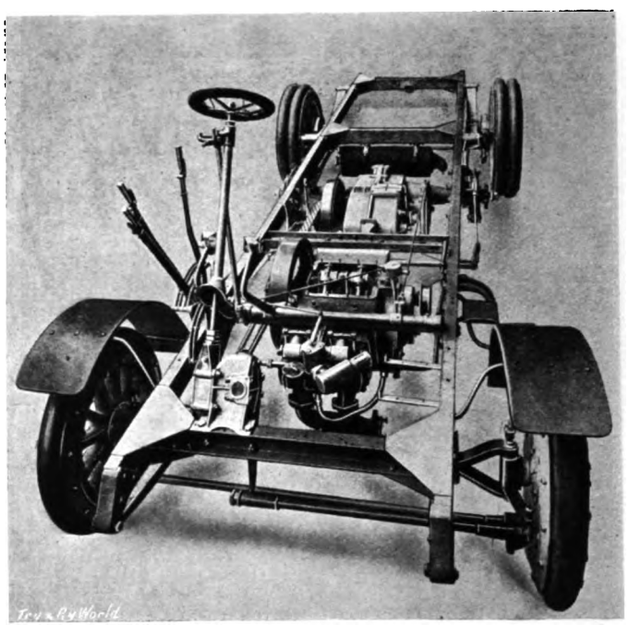


View of Straker-Squire 'Bus.

The wheels are of artillery pattern with metal hubs. The front wheels are 34 in. diameter, fitted with single solid rubber tyres, and the back 42 in. diameter, with steel tyres. The back wheels, however, may be fitted with either single or twin solid rubber tyres.

The engine is of the standard "Wolseley" type having two horizontal cylinders, 6 in. bore by 7 in. stroke, developing 20 B.H.P. at 600 revs. per minute. Half compression cams are fitted to ease starting. The drive to the gear box is through a "Renold" silent chain.

The gearing is enclosed in a dust-tight case,



Chassis of Wolseley Omnibus.

and runs in grease. The gears are of the sliding type, and give four forward speeds of 2½, 5, 8, and 13 miles per hour respectively, with the engine running at normal speed, and one reverse speed of 5 miles per hour. All the changes are made with one lever. The drive to the road wheels is from the ends of the differential shafts in the gear box, by roller chains, one to each rear road wheel.

The vehicle is provided with three independent sets of brakes. They are all metal to metal of the block type, and act equally well in both directions. The pedal brake operates on a water-cooled drum on the high-speed counter-shaft of the gear box. The side lever brake is equalised, and acts on two drums attached to the sprockets on the gear box. The emergency brake is operated by a lever in front of the driver, and acts on the inside of drums on the sprockets of the road wheels. This brake is also equalised.

No governor is fitted, but the engine is controlled by a hand throttle. The ignition is electric high tension, and is timed by a lever on the control column.

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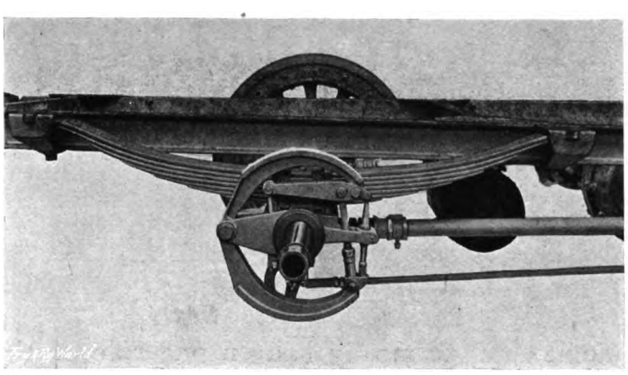
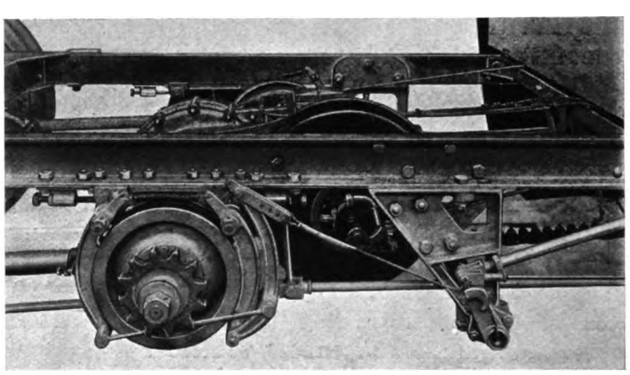
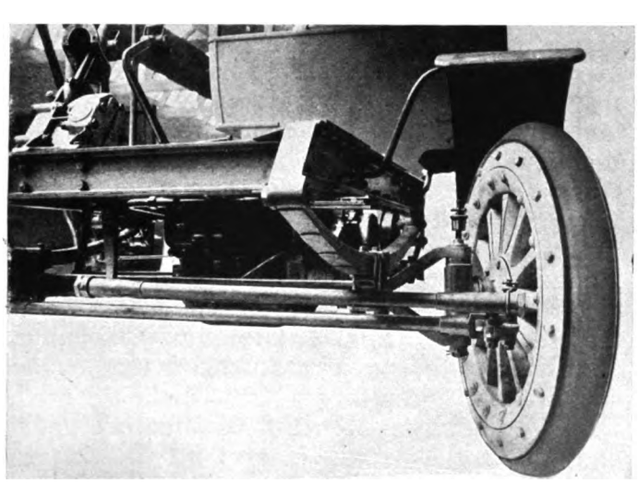
Wolseley Motor Omnibus, Built for the Great Western Railway Company.



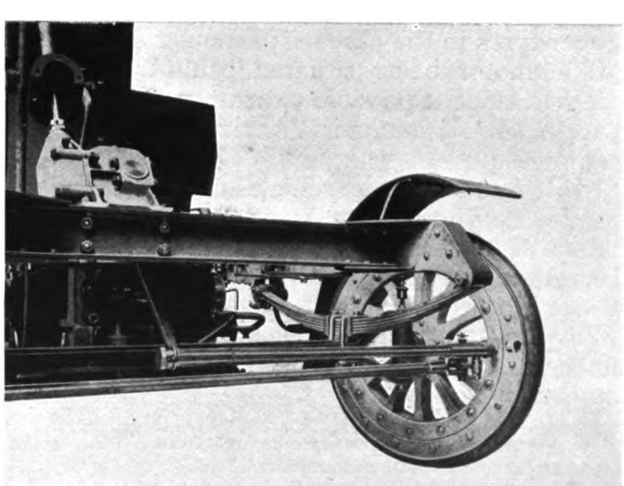
Wolseley 'Bus.—Foot-brake, Springs, and Back Axle.



Wolseley Gear Box, Showing Brake on Countershaft.



Wolseley Chassis.—Steering Arm.



Wolseley 'Bus.—Steering.

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The rear axle is formed of a weldless steel tube, while the front axle is forged in one piece. The steering is irreversible, being operated from the inclined pillar through a worm and wheel.

The radiator is fan cooled, an efficient silencer for the exhaust is fitted, and a sufficient supply of water is carried for cooling the engine. The petrol tank has a capacity of 10 gallons, which is sufficient for a run of about 60 miles with full load.

As a result of the design thus briefly outlined, the following advantages are claimed.

The employment of a horizontal motor, as it is placed below the level of the frame, permits the whole upper part of the chassis being utilized, and thereby provides a large carrying capacity without necessitating the use of an abnormally long wheel-base, as in the case of vehicles fitted with motors of the vertical type.

The connecting of the gear-box with the motor by means of a Renold's chain is a very necessary feature in vehicles of this type, as it makes a flexible connection between the two, and any strains which may be set up in the main frame cannot affect the transmission. The gear-box is suspended from three points, and the transmission from it to the road wheels, being by means of roller chains, permits the employment of very flexible springs, as any movement of the axle cannot affect the drive. Any one of the three independant brakes fitted can be applied instantaneously, and each is made powerful enough to hold the vehicle on a very steep gradient. These brakes are of the metal to metal type, and act in either direction, ensuring perfect control over the vehicle.

Another special feature is the pressed steel frame, which is not only much stronger than the ordinary frame, but also permits of a considerable saving of weight. These are the largest pressed steel frames which have as yet been used in the manufacture of motor vehicles.

A very large margin of safety has been allowed in the construction of the wheels. They are made of thoroughly well-seasoned timber, fitted with iron tyres for goods transport, and solid rubber tyres in the case of passenger vehicles.

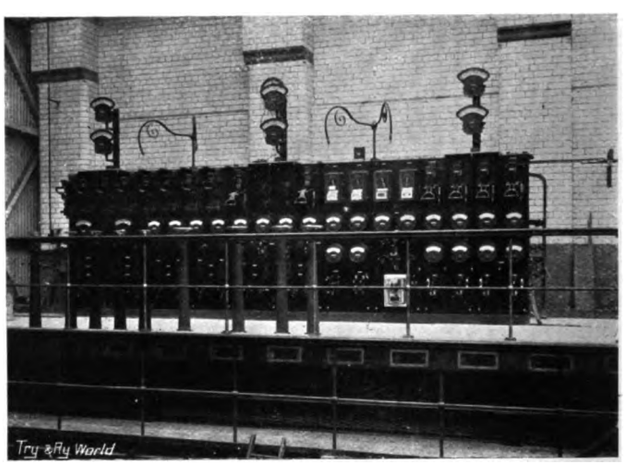
The motor being situated behind the front axle has made it possible to arrange the steering-gear in such a manner that it is very easy to manipulate.

In all details of these vehicles the high standard of Wolseley practice and workmanship has been maintained, and all important bearings are ground to ensure smooth running. Gravity lubrication is employed on the well-known "Wolseley" system, which has been so satisfactory in the pleasure cars turned out by this company.

ELECTRIC TRACTION ON THE METROPOLITAN RAILWAY.—A successful experiment was made on the Metropolitan Railway on the night of February 27 after the ordinary traffic had ceased. An electrically propelled train was run from Neasden to Baker Street, where it crossed to the Inner Circle line. From Baker Street the train proceeded to Notting Hill Gate and to Aldgate.

KILMARNOCK ELECTRIC TRAMWAYS.

The electrical undertaking of the burgh of Kilmarnock was formally inaugurated on Saturday, December 10, when the opening ceremony was performed by Lord Howard de Walden. Besides the installation of an electric lighting system for public and domestic service, the installation comprises 4¼ miles of tramways which have been equipped so as to combine solidity of construction with economy in capital expenditure. Two routes have been completed. One of these runs from Riccarton, where the car sheds and power-station are situated, through the centre of Kilmarnock to Beansburn; the other route connects the town with the outlying district of Hurlford. It is proposed to operate a ten-minutes' service upon each of these routes. There is one half mile of double track in the middle of the town, the remainder being constructed with single track and loops, the latter being spaced about three to the mile. The



The Switchboard at Kilmarnock.

single track is mostly laid on one side of the road; this provision being made to facilitate doubling, if necessary, at some future time. There are no seriously steep grades on the lines, the most difficult being one of 300 yards at 1 in 24.

The cars, of which eleven have already been delivered, were built by Messrs. Hurst, Nelson, and Company, Limited, and are of the usual double-deck type. They are carried upon single trucks made by Messrs. Hurst, Nelson, and Company, and are fitted with steel-tyred wheels, 31¾ in. in diameter, made by Hadfield's Steel Foundry Company, Limited, Sheffield. The electrical equipments for the cars were manufactured by Witting, Eborall, and Company, Limited, with the exception of the canopy switches and circuit breakers, which are of the British Thomson-Houston Company's make, and the trolleys, which are fitted with the swivelling head, and were supplied by Messrs. Estler Brothers. Movable steps are arranged to be operated from the platforms; these are

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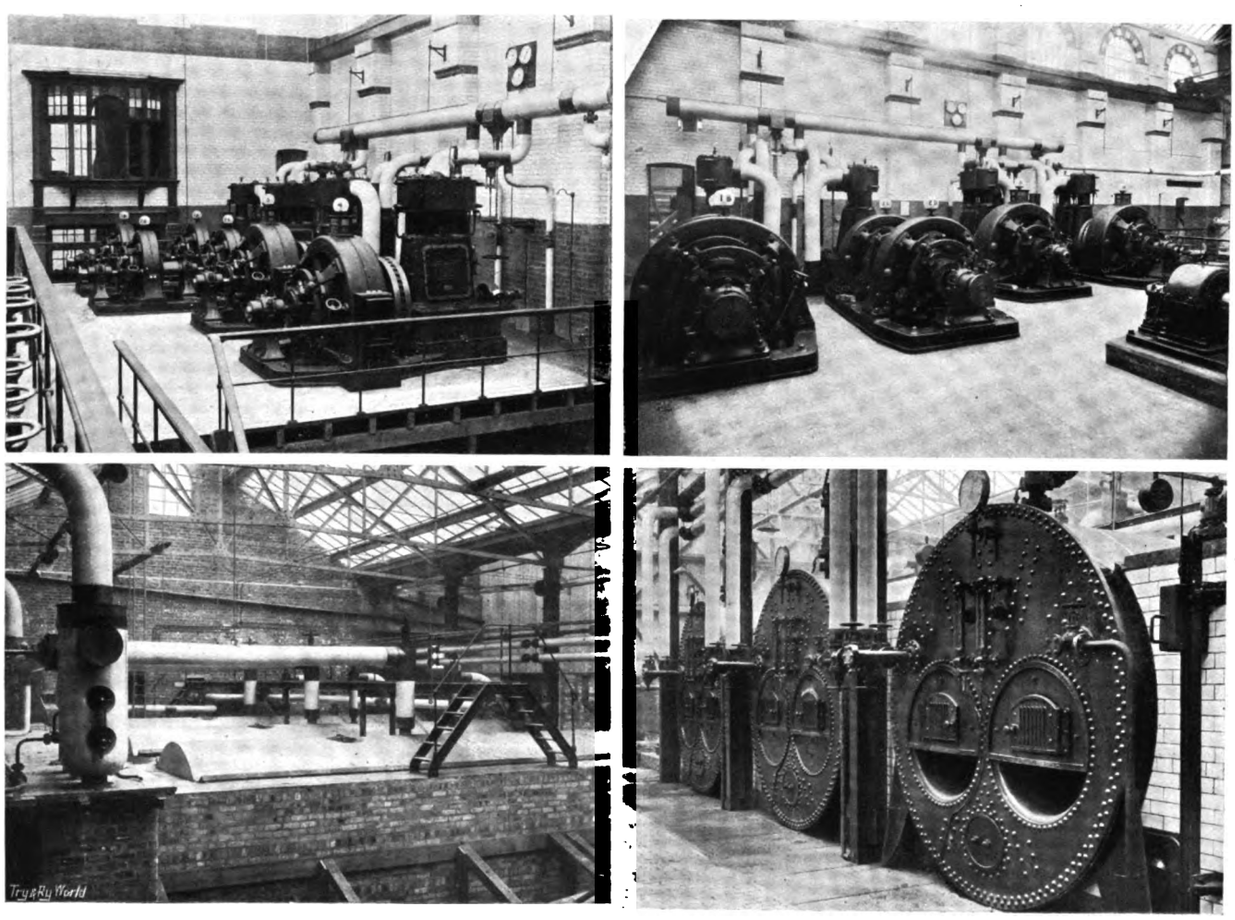
designed to allow of the proper action of the life-guards, which are of the Tidswell type. The finishing colours on the bodies are olive and cream. The cars are 29 ft. long, over all, and 6 ft. 9 in. wide, seating 30 passengers outside and 22 inside.

The car sheds and power-station, at Riccarton, occupy a site near the River Irvine; considerable space is available for future extension.

The car shed has three tracks, one of which runs over an inspection and repair pit. Each of these tracks will hold four cars. A repair shop is provided, and will be equipped with a complete selection of machine tools, to be used in repairs and the production of finished spares.



Station Views at Kilmarnock.

The situation of the power-station, close to the river, enables plenty of condensing water to be obtained. Coal, which at present is carted to the station, is eventually to be delivered direct from a siding of the Glasgow and South Western Railway. The appearance of the station and depôt buildings is extremely effective, the frontage being constructed in red stone and pressed brick. Commodious rooms are provided for the several departmental offices of the undertaking.

The engine room is 71 ft. 6 in. by 37 ft. 6 in. Four Belliss and Morcom compound condensing engines, each of 200 H.P., are installed, and are direct-connected to Dick-Kerr generators having a total capacity of 480 KW. Two engines drive 120 KW. traction generators, the other two sets being for lighting. Space has been provided for further generating plant. The accompanying views of the engine room, it will be noted, give a good idea of the neat and convenient arrangement which is characteristic of the whole installation. Jet condensers, by the Mirrlees Watson Company, are provided, the necessary water being drawn from the adjacent river.

Both traction and lighting feeders are brought to one main switchboard. The makers of the board, which presents some interesting features, are Messrs. Cox-Walkers of Darlington. The risk of fire has been obviated by the use of bare copper rod, supported upon insulators behind the switchboard, in place of cables. Generator field rheostats are placed under the switchboard platform, which is raised a few feet above the engine room floor level, and are worked from hand-wheels mounted on pillars close to the platform railings.

The battery, the room for which adjoins the engine room, consists of 254 cells of 360 ampere-hours capacity, supplied by the Tudor Accumulator Company. A booster is provided for use with the battery. The sphere of usefulness of the battery, however, is confined to the lighting system.

The boiler room is arranged for five boilers, three of which are now installed. They are

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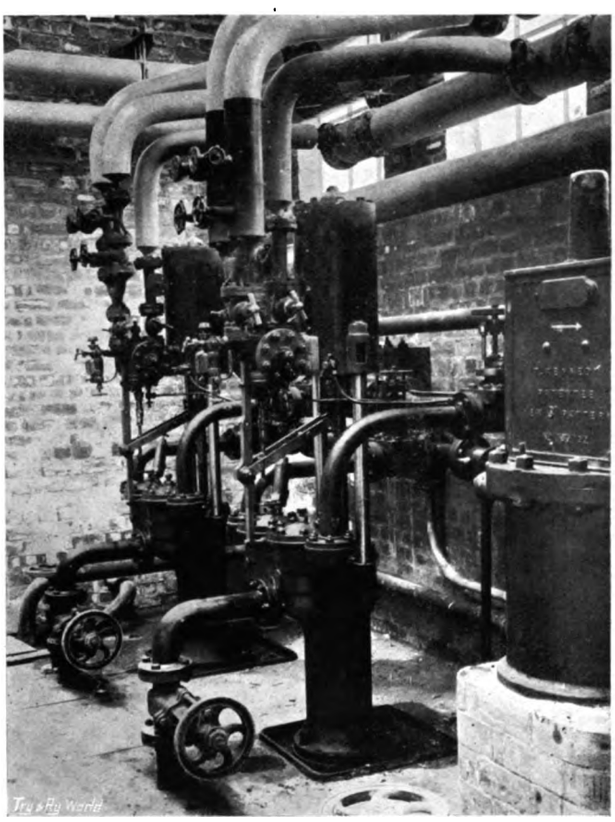
of the Lancashire type, 28 ft. by 8 ft., and were built by Messrs. Yates and Thom for a working pressure of 160 lbs. per square inch. The feed-pumps are by Messrs. G. and J. Weir, of Cathcart. No superheaters are installed. An economiser, having 192 tubes and made by Messrs. E. Green and Sons, and a feed-water heater, are in use; the feed pipes are so arranged that either may be laid off when required. The chimney is 150 ft. high. The main steam pipes, which are fitted with separators, are arranged as a ring; Messrs. Aiton and Company carried out the piping work.

The boilers are hand-fired, the coal used being from local pits and costing 7s. per ton. Water for the boilers may be drawn at will from the municipal supply or from the river.



Boiler Feed Pumps.

The permanent way is of the usual urban tramway type, girder rails weighing 90 lbs. to the yard being laid to standard gauge, 4 ft. 8½ in. The rail used is 6½ in. high with a base 6 in. wide; the groove is 1 1/16 in. in width. The rails were rolled by the North Eastern Steel Works Company, Middlesbrough. They are laid in lengths of 45 ft. The track is laid on a 6 in. bed of 6 to 1 concrete, 3 to 1 concrete being used for rail packing and grouting setts. The setts are of whinstone. Drainrails are laid where necessary, these being of Messrs. Dick, Kerr, and Company's make. Hadfield's special work and points have been used. The rails are connected with the "Dicker" joint; the fish-plates weigh 58½ lbs. per pair and are secured with six bolts. The track is double bonded at joints, and cross bonds are spaced 120 ft. apart. The track work has been carried out by Messrs. Dick, Kerr, and Company, Limited, whose works at Kilmarnock proved very convenient for the contract.

Messrs. Robert W. Blackwell and Company were the contractors for overhead equipment. The poles are of the three-section type, and have been erected without the usual cast-iron base, which would in many places on the narrow side-walks of "Auld Killie," form something of an obstruction. This portion of the construction is noticeably substantial, and the omission of unnecessary ornaments has no doubt made the cost correspondingly reasonable. Bracket arm flexible suspension is employed along the suburban portions of the routes, while within the town rosettes fixed to the buildings have been utilised for carrying span wires wherever possible. The whole of the insulators, hangers, etc., have bronze metal parts. The trolley wire is of 00 gauge, and, as usual, is of hard drawn copper and divided into half-mile sections. The span wires are of the heavy gauge of 7/12; stranded guard wires are used, these being of 7/16 gauge.

The distribution system consists, for the tramways, of one track feeder and three positive feeders. One of the positive feeders is of ·3 sq. in. sectional area, the other two being ·15 sq. in. The track feeder is of ·6 sq. in. area. All of these cables are laid on the solid system in wood trough; they are impregnated jute-insulated and lead-covered. Messrs. Callender and Company were contractors for this part of the work, and the same firm also supplied the section and signal pillars. Telephones are installed at each of the signal pillars, which are located at the loops, for communication with the station.

Mr. A. H. Burbidge acted as resident engineer for Messrs. Kennedy and Jenkin, and has been retained by the Corporation of Kilmarnock as engineer and manager of their traction and electric lighting system. We are indebted to Mr. Burbidge for his kindness in supplying us with particulars of the undertaking.

ACCIDENTS ON N.E. ELECTRIC RAILWAY.

In the House of Commons on March 1,

Mr. Weir asked the President of the Board of Trade whether he was aware that on February 20 a young woman named Alice Maughan, residing at Felling, was found lying dead across the electrified rail on the North Eastern Railway Company's line near Backworth, Northumberland; and would he call for a report on the subject, and state whether the electrified rails on this line were passed by the Board of Trade inspector as sufficiently protected.

Mr. G. Balfour said that the accident was notified to the Board of Trade by the railway company, and the Board had appointed one of their inspecting officers to inquire into and report upon the circumstances. The arrangements for working this line by electricity had not been "passed" by the Board of Trade, the railway company having adopted the new method of traction on their own responsibility, and without obtaining specific statutory powers involving preliminary inspection on behalf of the Board. The precautions adopted for the protection of the company's servants and the public had, however, come under the observation of the Board's officers when holding inquiries into previous similar accidents on this electrified line; and the company had informed the Board that they had complied with the recommendations made in the officers' reports on those accidents.

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THE ELECTRIC TRAMWAYS OF VARESE.

One of the most interesting and most picturesque tramways of Italy is the one which connects Varese with the Sacro Monte and the Campo del Fiori. Indeed the track crosses one of the finest districts of Italy, the far-famed region of the Lake of Como, which is known over the whole world, and which as far back as the Roman period was a favourite centre for country seats.

The line, of which the total length amounts to 5,900 metres—4,270 of these on communal and provincial roads, and 1,630 on private grounds—is worked by a central hydro-electric station situate at Ferrare. This station obtains its power from a waterfall 107 metres high on a branch of the Margorabbio near the Ponte-Nativo.

The works for collecting the water, close to the Ponte-Nativo, are constructed with great strength, in order to resist the onset of torrent floods which now and then rise in those parts. It comprises a dam with weir, sluice gates, and floodgates opening to the canal, and a bottom drain valve for draining the lake. This valve, of a special construction, acts also as an additional suction valve. The conduit is 530 metres long, its diameter is 750 millimetres, its thickness from 5 to 8 millimetres. The turbines, with horizontal shafts, belong to the Pelton type. There are three turbines, regulated by hydraulic motors. At full load they consume 340 litres each per second, and produce 375 H.P. They work at the rate of 450 revolutions per minute, and by means of an elastic sleeve drive a three-phase alternator of 250 KW., generating current at 6,000 volts and 45 periods. The turbines have an efficiency of 78%, the alternator 93%. The current generated by this central station is used not only for the tramway, but also for lighting purposes. For the purpose of the tramway from Varese to Prima Capella the current is converted. To this end a sub-station is placed at the foot of the hill of Sant Ambrogio. It contains two synchronous three-phase motors of 75 KW. each (with two continuous-current excitation dynamos), producing current at 550 or 600 volts, which is sent to the car-motors. The plant of this sub-station, as well as the car-motors, have been supplied by the Thomson-Houston Company. The station comprises besides, two vertical steam engines, which can work the dynamos in case of stoppage in the service of the central station.

View on Varese Railway.

Next to the engine-room is the workshop for repairs and the house for the carriages. The motor-carriages are provided with two block-brakes and one powerful electric brake. They

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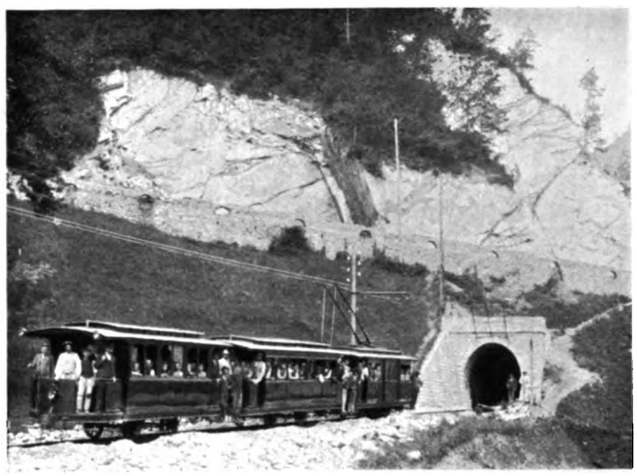
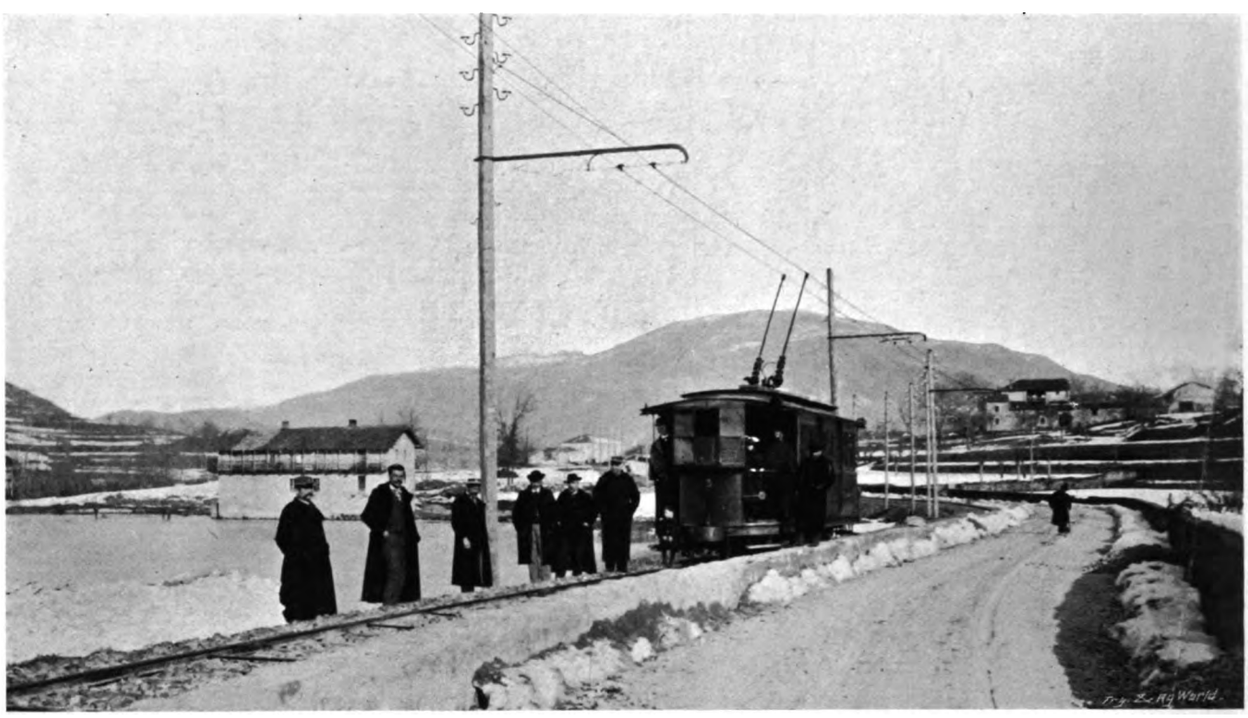
can be stopped within a few yards even on the steepest slopes. They have been constructed by the firm of Fratelli Macchi, of Varese. The frames have been supplied by Miani and Sylvestri, of Milan.

The lighting of the motor, as well as of the other carriages, is done by electricity. The journey over the entire line is completed in about 27 minutes. The rate of speed allowed is only 6 kilometres per hour within the town, but it may reach 20 kilometres per hour outside the town on sections of straight line. The gauge of the rails is 1·10 metres. The steepest slope reaches 7·20%. The smallest radius of curvature is 24·50 metres. The current is taken by trolley from an overhead wire. The latter is of copper, its diameter being 8¼ millimetres, and it is stretched at 6 metres above the level of the line. There is no distinction of classes in the carriages. The fare varies from 10 to 50 centimes, and the money is collected on the cars. The managing society supply also family tickets and season tickets at the price of 5 lires a year, allowing the holder to travel any distance whatever by paying 10 or 20 centimes, according to the days. These season tickets are delivered without any other formality than the exhibition of a photograph.

Starting from the North Railway station, the tramway runs through Varese to the Viale Azuggiani. Then it runs through the splendid Viale della Rotonda, which in certain places offers a slope of 5%. Leaving the Rotonda the line crosses the provincial road and reaches the Salita di Sant Ambrogio and the electric works. There the tramway enters its own grounds, and



Train at Tunnel Entrance.



An Open Portion of Line.

One of the Stations.

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ascends the hill with a slope of 7% to arrive at Sant Ambrogio, whence it continues its progress until Robarello. As soon as it reaches Robarello the line enters the finest part of its entire route. After a few meanderings the railway extends in a straight line, and reaches a rather steep declivity. Then describing a wide curve the line arrives on a great platform, about 10 metres high, close to Selvapiana. The verdure of the hills and of the rich fields, the sparkling of the waters of the lake, the silhouette of the far-away mountains, the blue of the skies, harmonize and blend together in a symphony of light and colour. From Selvapiana to Prima Capella the journey occupies only a few minutes.

This line finds its natural complement in that of Varese to Luino, which is worked from the same central station, and acts as a connecting line between Varese and the Lake Majeur. It runs through a landscape interesting through the beauty of its panoramas and the delights of the district. The first part crosses Italian Switzerland, the second occupies the southern slope of the Valcuvia, whence the view extends as far as Lake Majeur. The extensive belt included between Lake Majeur and the Lake of Lugano on the one side, and the Lake of Varese on the other, which until recently was without rapid means of communication, has entered on a new era through the installation of the lines we have described, and many industries which were drifting towards ruin in the country will doubtless very soon acquire a new vitality.

Another central station is planned on account of the "Sosietà Varesina" on the left bank of the Giona in the commune of Maccagno Superiore. This new station will use the water of the Giona. The power thus generated will be used by the company for lighting purposes and for motive power along the line Varese-Maccagne, with a view of favouring the industry of the country.

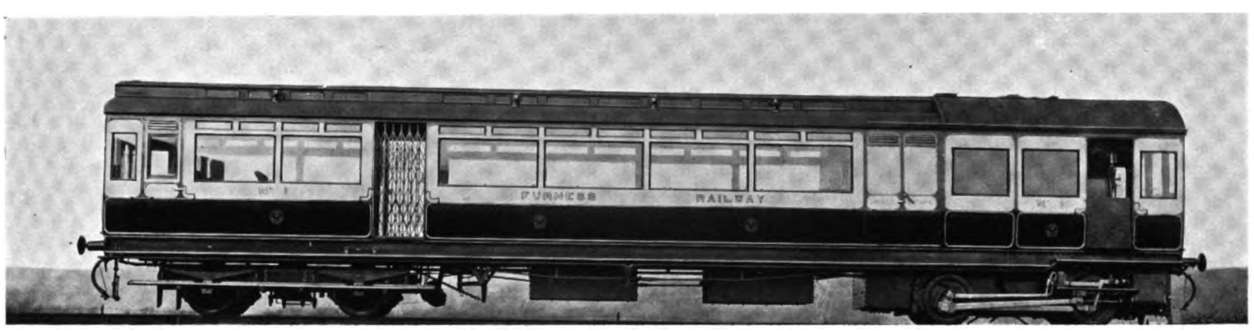
STEAM MOTOR COACH FOR THE FURNESS RAILWAY.

With a view to the economical working of the passenger service on the Windermere branch between Ulverston and Lakeside—a distance of about 10 miles—the Furness Railway Company have just completed a new rail steam motor-coach, which has been designed by Mr. W. F. Pettigrew, M.Inst.C.E., and been built by the company at their own workshops at Barrow-in-Furness.

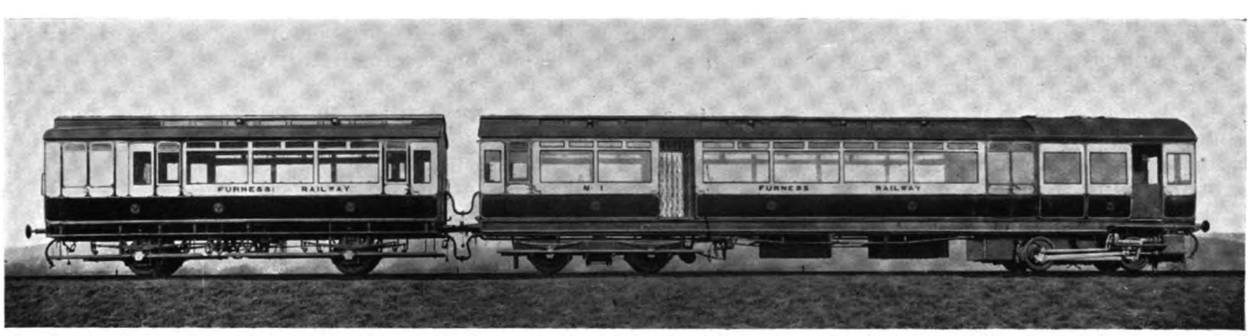
The seating capacity is for twelve first-class and thirty-six third-class passengers, a luggage-compartment also being provided. Transverse seats have been arranged in both compartments, the first-class being upholstered in moquette, and the third-class in rattan, the whole being electrically lighted and heated with steam throughout. The car body is framed in teak, with clerestory roof, whilst the engine-compartment is built entirely of mild steel sheets and angles, panelled to correspond with the other portion of the carriage body. The underframe is also built of steel channels throughout, carried at one end by the standard carriage bogie, the other end being supported by the engine bogie. The total length of the car over buffers is 60 ft. 11 in.; distance between centre of bogies, 40 ft.; and total wheel-base, 48 ft.

The cylinders of the engine are 11 in. diameter, with a stroke of 14 in., operated by means of the Walchaert valve-gear, with coupled wheels, 2 ft. 10 in. diameter. Steam is generated by means of a locomotive type of boiler, having a working pressure of 160 lb. per square inch, which is placed with the firebox to the front end, giving a clear outlook for the driver. The tank has a capacity of 300 gallons, and is placed on the engine bogie over the driving wheels, whilst the coal is carried in the motor compartment. Provision has been made for controlling the steam throttle-valve, vacuum, steam and hand brakes, and whistle from either end of the coach.

A trailer for the rail motor car has also been built in the company's works. It is similarly fitted up to the car, and will accommodate thirty-four passengers. The interior is lined with wainscot oak and is 30 ft. long. A luggage compartment is at one end, and electric light and heating apparatus are fitted.



Furness Railway Steam Motor Car.



Furness Railway Steam Motor Coach and Trailer.

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THE COMPARATIVE LEGAL CHARACTERISTICS OF TRAMWAY "RUNNING POWERS" AND "FACILITIES."

By a Lecturer in Transport in the London School of Economics.

In every process of national development of facilities of rapid transit, however diverse may be a country's political or municipal institutions, three well-defined stages in general mark the evolution of tramway transportation and its advance towards maximum convenience and efficiency. The first epoch embraces the establishment in urban districts of systems of tramways for purposes of purely local traffic, limited in mileage by the inevitable deficiencies of horse traction as the motive power; in England in addition, by the policy of the Tramways Act of 1870. The second occurring era is distinguished by the introduction of electric traction, a consequent expansion of the functions and potentialities of tramways as means of passenger conveyance, and the general establishment of extensive tramway systems in suburban and many of the less sparsely populated rural localities. The final period is universally remarkable for the disappearance to a great degree of the restricting influences due to the extensive subdivision of ownership that characterised the earliest epoch, by consolidation, undertaken directly no doubt for ordinary commercial considerations, but indirectly benefiting the recently created and steadily increasing through traffic, or expressly in the interests of such traffic by the special provision of through communication without change of car over systems separately owned. It is with the latter feature that this article is concerned.

In no country in the world are the characteristics of this final stage so abundantly exemplified and well defined as in the United States; nowhere do the same facilities exist for through tramway travelling. With every improvement in electric traction came increased construction of interurban electric railways on the heels of a more rapid increase in tributary population. But the objective of interurban passengers was generally the town served by the connecting but independent urban tramway. Transhipment at the point of junction was against the natural order of things. Through travelling in the end was the rule, either as the result of consolidation or of expressly arranged through communication.

Conditions in England practically prevent such consolidation. In the United States municipal operation is unconstitutional in most states, and nonexistent in all, if one were to except a small western town which, when the writer was last in the United States, through non-payment of rates had come into the possession of, and worked a tramway one mile long, the total equipment of which was two cars and four horses, and which, he was informed, was the single illustration of municipal operation that the States presented. Indeed, in the whole of North America at the time of writing the Corporation of Port Arthur, in Ontario, is the only other municipal tramway undertaker. But in England conditions are otherwise, and an annually increasing number of municipalities own and operate tramways. Many of these tramways are in suburban connection with those belonging to companies. Between corporation and company consolidation is impracticable, so that the only possible alternative resource for providing for through traffic is the institution of through communication in some form or another.

There are signs of the times to show that tramway development in England has entered on the final stage. It would be offensive to the intelligence of our English tramway managers, whose efforts are unceasingly directed to the provision of those facilities of locomotion that are needed, and a matter of supererogation to urge the necessity of through communication where public convenience requires it. As to the deterrent effect on travel, the public inconvenience and the many disadvantages of transhipment, there is unanimity between manager, passengers, and public. But acrimonious discussion frequently centres round the method by which such through communication should be established, either to use the terms in common parlance by "Running Powers" or by "Facilities," without general agreement as to the distinguishing characteristics of these methods. Moreover, there are, unfortunately, those who would dogmatically prescribe as a general proposition the expediency of one or other only of the methods, apart from the circumstances of the particular case under consideration.

In view of the increasing public demand for through tramway communication, it is essential for technical and economic discussion of the subject and for effective comparison of the respective conditions in different countries in relation thereto, that there should be definite and accurate conceptions of the meaning of these terms and of the inherent differences between the methods of through communication so described. The distinction almost invariably but entirely inaccurately drawn is that a "Facilities" arrangement is accompanied by "Change of crew," and much argument advanced both for and against that method is founded on this supposed inevitable concomitant. Such change as explained below is of itself an unimportant incident, and may be found to exist with either an arrangement for "Running Powers," or for "Facilities." Indeed many "Facilities" arrangements, and this may be strange to English readers, are to-day in operation without any "Change of crew."

There are in practice two methods and two methods only, call them what you may, each with two subdivisions, under which through cars can be run from one tramway system on to and over another, and the fundamental distinction is not the incident of "Change of crew," or the fact that for the journey one through fare is taken or several local fares, but solely turns on the question of whether, using the term "running party" to mean the tramway undertaker owning the through cars, and the term "owning party" the undertaker owning the foreign lines over which the through cars are operated, it is running party or owning party that under agreement or enactment is the one legally operating, and responsible for damage caused by the through car on the subservient line. In the one case the running party operates its cars over the subservient line as if that *line* were its own. In the other case the owning party receives on to and operates over its lines the foreign cars as if such *cars* belonged to it. The character of an arrangement provided for by an English Act of Parliament is usually clear from the terms of the statute, but in regard to the nature of a traffic agreement, especially one concluded in the United States or on the continent of Europe, there is no conclusive and distinguishing test save that which is mentioned above.

The term "Running Powers," is entirely of English origin, being practically unknown abroad, and covers the case where the running party performs the operation of the cars and is legally responsible in respect thereof over the whole length of the through journey. In the United States the analogous term is "Trackage Rights." The term, "Facilities," likewise indigenous to this country, is generally applied to the case where the cars of one party are passed on to a foreign system, and are then received on to and operated over that

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system by the owning party exactly as if they were cars of that latter party. As used in connection with tramway operation the term, "Facilities," seems to have been borrowed from Sec. 2 of the Railway and Canal Traffic Act, 1854. That section speaks of "facilities for the receiving and forwarding and delivering of traffic . . . and for the return of carriages, trucks, boats, and other vehicles." As applied, however, to tramways the term is denuded of the explanatory qualifications which serve in that section to explain its meaning. The equivalent term in the United States is, "Forwarding of Traffic," or "Traffic Exchange." More commonly, indeed, an agreement for "Running Powers," or "Facilities," in the United States is indiscriminately referred to as a "Traffic Contract," and as the writer has found in investigating a large number of the principal cases of through communication into the chief cities of that country, it is only on application of the test above described that the case can be appropriately classified. Adopting, however, English phraseology, through communication may be instituted between one tramway system and another in any one of the four following ways:.

I.—"RUNNING POWERS."

1. Change of crew.	In either case	Through fare, or
2. No change of crew.		Separate local fares.

Running party operating and responsible for car throughout journey of car.

II.—"FACILITIES."

3. Change of crew.	In either case	Through fares, or
4. No change of crew.		Separate local fares.

Owning party operating and responsible for through cars on owning party's tracks.

Probably the second and third cases are the only methods so far adopted in the United Kingdom. But the first is, however, in existence in the United States. There are a number of instances known to the writer in the United States where a suburban company exercises running powers into a city over the tracks of the urban company, but by the terms on which the powers are exercised is bound, or for local reasons prefers, to replace in whole or in part the suburban crew by crews specially employed for operation within the city. The second is the more usual form of a "Running Power" arrangement, and usually constitutes in the United States the modern method under which through communication is provided. The third case is that which is ordinarily understood in England as one of "Facilities," usually because it is characterised by "Change of crew." The fourth, however, is found to exist in the United States, where crews of the running party, on passage of the car on to a foreign system, are *ipso facto* and *es instante* the servants of and for the time spent on that system paid by the owning company. This method, for instance, it may be mentioned is in actual existence in the city of Cleveland. In these four ways under one or other of the two available methods, through communication has been provided in the United States. It will thus be seen that with "Running Powers" there is so far as the passenger is concerned a single transportation authority with undivided jurisdiction for the journey, but with "Facilities" one single transportation authority with undivided jurisdiction over that portion of route of which it is the owning party.

In the United States more than in any other country, one finds, as has been mentioned, "Running Powers" and "Facilities" arrangements in abundant profusion and general use. That is the writer's excuse for referring so frequently and at such length to the procedure and practice in that country. Partly due to the fact that, in early days, the managers of street railways in that country had been originally trained on steam railroads, and when any arrangement for through communication was proposed instantly bethought themselves of those arrangements then prevalent on steam roads whereby the wagons of the various "Transportation lines" were forwarded from road to road, and partly due to the natural limitations of horse traction, the early arrangements for through communications were invariably instituted under the method of "Facilities" with "Change of crew." In many cases, especially in the New England States, those arrangements were even after electrification retained, really as more than one manager assured the writer, because no one cared for the disturbance of existing contracts and conditions.

In point of historical sequence, the next method of through communication to be adopted was a "Facilities" arrangement without change of crew, this time in the States of the Middle West. As the foreign car, with its passengers and crew, passes off its own system on to a system differently owned, the company to whom the latter system belongs takes over the through car and crew and operates it over its tracks exactly as if it were its own car, paying the foreign company for the time spent by the foreign crew off the foreign system, the time being mutually checked by the interested companies at the point of junction. Finally, the "Running Power" arrangement without change of crew as we know it, was arrived at, and seems to constitute the method under which, at the present day, through communication is provided for in the United States. Nearly every large city affords examples of this method.

A comparison of the respective legislative machinery and conditions existing in England and the United States in relation to the establishment of through communication by "Running Powers" or "Facilities" is exceedingly interesting. In England a tramway undertaker obtains "Running Powers" over, or "Facilities" from, the adjoining system of another undertaker, either by agreement with such other undertaker or, if public expediency as proved to Parliament so requires, by virtue of a special Act of Parliament promoted for that pnrpose. Following settled railway practice a tramway "Running Powers" Act is usually drafted so as to confer power to the running party (1) to run over (a) *defined* routes for (b) *defined* classes of traffic, and (2) to charge thereon the rates and charges authorised to be charged thereon by the owning party, and provides that such running (3) shall be on terms to be agreed or settled by arbitration, and (4) subject to the by-laws and regulations of the owning party, and in the case of two adjoining systems on each of which fractions of a mile may be charged for as whole miles, such Act provides in order to prevent fractional portions of a mile traversed on each system being separately charged for, (5) that the two tramway systems shall be deemed to be one tramway. Two tramway undertakers may, as already mentioned, mutually agree for the exercise of similar running powers, the one over the system of the other, but to ensure validity, especially in relation to passengers and the public, such undertakers must be empowered by an enabling clause in a special Act of Parliament to make such agreement, and in that event to exercise the powers of (2) above. "Facilities" may likewise be secured by special Act or arranged for by agreement. There is as yet, unfortunately, in this country no settled form of tramway "Facilities" enactment, though the framing of an appropriate clause is perfectly practicable. The ordinary form of railway facility clause sometimes adopted is inapplicable from the diverse nature of tramway from railway conditions, and if so applied opens the door to litigation. It would seem, however, that apart from the question of charging through fares, no special statutory authority is

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necessary to enable tramway undertakers to provide or avail themselves of "Facilities."

The method of obtaining compulsory "Running Powers" or "Facilities" in the United States is notably different from English practice. In the States the necessary power and privileges must in theory be obtained from the State, but in practice through State devolution of authority by indirect agencies, and seldom or never by special Acts of the Legislature. There the constitutionality, an essential requisite for validity of any statute of a State Legislature, or the legality of an ordinance of a municipality, is always a matter to be tested in the courts. As a result judicial decisions on statutes or municipal ordinances authorising "Running Powers" are veritable store-houses of enlightened criticism of such methods of through communication, viewed from the social, economic, industrial, indeed every possible point of view. A few words will explain. In the United States a "street railway" company constitutionally obtains incorporation, or after incorporation extension of the purposes of the company, matters appertaining to the sovereign power of the State, in one of the following ways, according to the State:

	Number of States.
Under general laws only	41
By special Act only	4
By either method	6

Inasmuch thus as the granting of exclusive privileges by special Act of the Legislature is prohibited by most of the State Constitutions or State statutes, the most ordinary method of obtaining incorporation or extension of corporate purposes is to procure registration by the Secretary of State in prescribed manner of what nearly corresponds to the memorandum of association of an English company under the Companies Acts, which on the granting of his certificate is known as a "Charter," in which are described and authorised the objects, or extended objects, of the Company.

Thus, as a first step, a company desiring "Running Powers" over another company's line must, of necessity, obtain a "Charter," wherein the obtaining and exercise of such powers would be set forth as one of the objects, or extended objects of the company. Although in theory a State Legislature, except as restrained by the Constitution, has untrammelled power, and is so supreme over public ways that it could authorise the construction and operation of tramways in streets, this prerogative is usually exercised under general laws and through the agency of the police power of the municipal authorities. In many States constitutional inhibitions deprive the State Legislature of the power of granting the right to construct and operate street railways without the consent of the local authorities; in others whose Constitutions are silent on the subject, statutes have invested the local authorities with power to grant or withold a street railway "Franchise"; in all States the consent of the local authorities is required. Thus, as a rule, the second step for a company seeking power to construct a street railway or seeking "Running Powers" over another system is to obtain a "Franchise" from the local authority, which confers the power and prescribes all the conditions which shall regulate the exercise of the power. The "Franchise" in form and for all practical purposes is the same as an English special Act of Parliament, but different in one respect, inasmuch as the local authority may at the time of granting, or thereafter from time to time, attach such valid conditions as they think fit.

In connection with the legality of many municipal ordinances conferring street railway "Franchises," there have been numerous decisions turning in each case on the terms of the Constitution of the particular State, all leading up to the right of the municipality in the exercise of its police power to grant "Running Powers" over the lines of companies operating tramways within their district. "Streets," thus the decisions run, "are for the purposes of locomotion;" "a tramway facilitates locomotion and lightens the burden of the street": "a municipality cannot grant an exclusive right to any company for the sole use of the street," "and can grant a franchise for the laying down of tracks in a street already provided with tracks, provided that the sum total of tracks do not prove an impediment to the general traffic;" and then the final decision, clinching the matter, that "where public convenience so requires, a municipality can, subject to the payment of compensation, grant the *joint use of existing tracks* to a second company," and that "although it will involve changes in track and roadbed to adapt them for a different kind of motive power."

It may be, however, that if a particular case were carried to the Courts, the latter would decide that on the particular circumstances thereof, it was beyond the power of the municipal authority to grant a "joint use of tracks." Still another method remains to the Company desirous of obtaining such, that of seeking the exercise of the privilege of appropriating such use under the power of "eminent domain." Eminent domain is the inherent, and except so far as limited by Constitution, the unfettered right of a sovereign State to "condemn" or allow the "condemnation" of a necessary amount of private property, or such requisite easements or rights thereover, for particular uses, where such "condemnation" promotes and is for the general welfare. To subjects, the State can by statute delegate the exercise of this right, subject to the payment of compensation, it being left to the competent courts, to whom application must be made for a "condemnation" order, to say in each case whether the particular use for which the property, or any rights or easements thereover, are proposed to be "condemned" is a public use. Tramway or railway purposes constitute in every State a "public use." And so in this way, by application to the courts, on proof of public convenience, a street railway company can frequently "condemn" a "joint use of tracks," and, therefore, procure "Running Powers" over the lines of an adjoining company.

In some States there is yet one other method, as for instance in Massachusetts, where the Board of State Railroad Commissioners are empowered by statute to grant to one tramway company the "joint use of tracks" forming part of the connecting lines of another company, if the Board are satisfied that such through communication is required in the interests of the public.

No power, curiously enough, exists in an American municipality to compel "Facilities" to be furnished by one tramway company to another, nor does there seem any constitutional means by which one company can obtain any such compulsory rights, except possibly in those few States where such privileges could constitutionally be obtained by a special Act. It is open under most of the States Railway Statutes to any two companies to grant one another "Running Powers" or "Facilities;" in the former case it would occasionally be necessary for the running company to obtain the necessary extension of its "Charter." The consent of the municipal authorities having jurisdiction over the lines run over would in some cases be required in the case of "Running Powers" being granted by agreement: but no power as to the charging of fares on the lines run over is required, the question of fares on all tramways in the United States being generally construed to be a matter of contract between the company and the passenger.

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It is of practical interest to notice the specific matters in American "Running Powers" or "Facilities," agreements in respect of which definite provisions are made, presumably as the result of extended experience and observation. The usual "running agreement," excluding provisions relative to matters of merely local or circumstantial importance covenants for (1) running powers and provides for (2) terms as regards payment, headway of cars, type of cars, speed, repairs of track, equipment, etc., (3) the operation of the cars on the lines run over being subject to the control and regulation of the owning company, (4) at the full liability of the running company, (5) with maintenance at the mutual expense of inspectors at points of junction of respective systems and the right to the owning company's inspectors at all times to board through cars and insist on certain checks on the number of passengers; (6) for mutual rendering of accounts, and for (7) the owning company being entitled to call upon the running company to dismiss any conductor or motorman disobeying the orders or operating contrary to the regulations of the owning company, with an appeal in case of refusal to arbitration.

A form which this latter provision often takes is worth setting out in full:

"The running company shall not at any time employ any motorman or conductor who has for any reason been out of the employ of the owning company for a period of less than six months.

"Before any motorman or conductor shall undertake any duties on any cars of the running company operated by that company over any route of which any lines of the owning company form part they shall each be made familiar with the route, so far as the same comprises any lines of the owning company, and with the rules and regulations of the owning company.

"The running company shall require such motormen and conductors at all times to obey such rules and regulations in the operation of cars over the owning company's tracks, and on their failure to do so the running company shall, on the complaint of the owning company, discharge any such motormen or conductors disobeying the same."

The writer was assured of the efficacy of this latter provision as entirely conducive to maintenance of the discipline of the owning company, and of an amicable *modus vivendi* between the two contracting parties.

The usual "Facilities" agreement in the same way, with the same exceptions, provides for (1) the forwarding of the cars by the owning company on (2) terms as regards payment, headway between cars, number of cars, etc.; and for (3) the owning company taking over and operating the cars at their own expense and liability, (4) but with a right to them to refuse to receive any cars, if such cars are unsafe or in disrepair, and (5) in order to provide against the risk of the owning company being forced to operate cars with an insufficient number of passengers therein to pay for cost of movement often compels the foreign company to guarantee a minimum revenue per through car to the owning company; and further provides for (6) mutual accounts and (7) checks.

As regards terms, as no property or rights over property can constitutionally be taken in the United States without payment of compensation, proper payments must be made in respect of compulsory "Running Powers," whether obtained by municipal ordinance or by right of eminent domain, or in any other way. In the first case the compensation is settled by the municipality, from whose decision there is no appeal; in the second case by courts allowing the exercise of the right of eminent domain from whose decision an appeal lies to the courts of "last resort," and under Massachusetts procedure by the Railroad Commissioners. The various decisions of the courts as to the terms on which running powers should be allowed are most valuable, and the *ratio decidendi* quite applicable to English conditions.

"Change of crew," wherever the same is prescribed for, is the subject in all American agreements of a great many covenants and stipulations providing against delay to passengers, loss of time of waiting crew, provision of waiting rooms for crews and others, and other implied consequences of such change.

A running power agreement in the United States usually provides for the running company taking all through and local fares throughout the journey, and paying the owning company either a definite proportion of each class of fare, or a sum per car traversing or per car mile operated over the owning company's lines. There is, however, no uniformity of practice as to the matters which are to be included in settling the owning company's proportion of fares, or the payment to be made to it. The ordinary rule of this country in respect of railway running powers as to the terms of the allowance to the running company is not adhered to, and a running company frequently is found to be allowed a profit in respect of through traffic brought to and carried over the owning company's lines.

In the case of an American "Facilities" agreement the terms are settled on the basis of the owning company being entitled to all local fares on its own line, and a certain proportion of each through fare, and as the owning company is virtually in the position of having temporarily hired the cars of the company owning the through cars, the owning company—according to the settled practice—pays the other company a definite sum per car-mile intended to cover in respect of each car for that distance, (1) interest, (2) maintenance, and (3) renewals and depreciation. Occasionally attempts before arbitrators have been made by the owning company to obtain a deduction in respect of increased wear of track by cars of the foreign company, such cars being alleged to be in excess of the ordinary local traffic requirements of that section of the owning company's system, but this claim the writer is informed has never been allowed on grounds unnecessary to state here. On the matter of the proportion of the through fare the practice is not settled, the company owning the through cars in many cases obtaining more than its mileage or fare zone proportion, on account of the through traffic it has collected and brought to the lines of the owning company.

Space does not allow of discussion of the interesting arrangements, statutory and otherwise, for through communication in France and Germany. Though clothed in sometimes an unrecognisable form, they can in the way described be classified as one or other of the two methods.

In this article no attempt has been made to discuss the economic considerations which apply to the adoption of one or other of the two methods of providing through communication. A comparative discussion of such matters would be a lengthy business, but this much may be said, that it is fallacious as a general proposition to proclaim the excellence as is so frequently done of one above the other. Only having due regard to the circumstances of each particular case is it possible to prescribe that which is best in the interests of the tramway undertakers concerned, or of passengers or of public.

Electric Tramways in Damascus.—It is reported from Constantinople that the syndicate associated with M. Empain, the Belgian financier, who is connected with the Paris Metropolitan Railway and other electrical enterprises, has acquired from Izzet Pasha the concession granted to the latter by the Sultan for the construction of electric light and power works and tramways at Damascus. The *Frankfurter Zeitung* states that the syndicate has paid for the transfer of the concession £20,000 in cash, and £4,000 in shares of the company to be formed to carry out the scheme, with a share capital of £250,000. The concession carries with it the right to utilise for the production of electrical power all the available water power within a distance of eighteen miles of Damascus.

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THE

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Motor Omnibuses.

Elsewhere in this issue will be found some description with illustrations of various makes of motor omnibuses now on the market. Talk of the coming of the motor 'bus has been going on for two or three years, and now that it has come it is to be hoped that it will do something to justify the hopes of those who are putting their capital into the business. In some of the halfpenny newspapers wild statements have been appearing about motor 'buses superseding tramways. It is but fair to say that this kind of rhetoric has not been indulged in by well-informed people who are pushing or supporting the motor 'bus idea, but the popular mind must have been led a good deal astray by that class of writers whose only object is to get hold of a "sensation" or an attractive "story" for the day, heedless of what the future may show. A few thoughtful articles have appeared in the engineering press, and the conclusions therein arrived at have been similar to those which we have on several occasions placed before our readers. Briefly, these are that the motor 'bus can hardly expect to work at a lower cost per mile run than the horse 'bus, that it will, however, have a higher earning power, that it will be a welcome substitute for the horse 'bus in districts where there is not sufficient traffic to warrant tramways, or in places like the city and west end of London where no tramways are allowed, and that it will be a useful feeder to tramways, but that it will have no chance in competition with tramways where there is at all a heavy business to be done.

* * *

This is not the place to enter into the arguments in detail, but we may note two points in support of our views which do not appear generally to be taken into account. One is that it requires two 'buses to carry the same number of people as a tramcar can accommodate. The two 'buses cost £1,800; the tramcar costs, say, £600. For a frequent city service about ten cars per mile of route are necessary, costing about £6,000. The requisite twenty 'buses would cost some £18,000. The difference is enough to pay for a mile of double tramway track. The second point is that it costs twopence per mile run to maintain the omnibus indiarubber tyres, against a minute fraction of a penny per car-mile for tramcar wheels. Even though the service of 'buses only produced 500 'bus-miles per mile of route per day, say a five-minute service, the cost of tyres per mile of route per annum would be about £1,500, which capitalised at 5 per cent. represents £30,000, or in itself more than the whole capital required per mile for a tramway, rolling stock, and power-station. The comparative estimated figures quoted on another page as regards Wolverhampton present the electric tramway in a very unfavourable light, as the cost charged for current is enormous, and special expenses for the Lorain system are included. It seems often to be assumed that a motor 'bus will earn as much per mile run as a tramcar. Seeing that it can only carry half the number of passengers, that cannot be done except by an inadequate service and overcrowding. These points at present, however, are more or less academical, as the motor 'bus needs to advance a long way before one can imagine it

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capable of handling a heavy traffic like a tramway, and as its actual working expenses under such conditions are as yet uncertain.

* * *

We do not, however, wish so much to dwell on these comparisons here, as to point out that the makers of autocars have so far been very successful in devising a form of their well-known engine and gear calculated to stand omnibus work. The machinery is of a high order, and an examination of it at the recent motor car show in London could not fail to impress the observer. Much engineering skill and attention to detail were manifest, and it was plain that the motor 'bus is becoming a practical commercial vehicle. A proof of the truth of this is the action of the London omnibus companies in taking up the new vehicle. If it proves at all successful, its success will be a great boon to Londoners, for the accommodation will be better and the speed greater than with the horse 'bus, and the streets will be immeasurably cleaner. In London there is room for every kind of improved means of locomotion. In semi-rural districts also, the motor 'bus should have a great future, and it should help both tramways and railways. The objections to it, as compared with tramways, disappear altogether when only an infrequent service has to be given, and for such work it ought to prove supreme. When the time comes, if it does come, when metal tyres can be used on the wheels without causing undue vibration to the passengers, an enormous step will be taken in advance, and the field of operations for the 'bus will be much widened. Meanwhile, the attention of readers concerned in the improvement of communication in the smaller towns and rural districts, as well as in London, may well be directed to the article in our present issue, and then to specimens of the omnibuses themselves.

Thames Embankment Tramway.

Once more we are having the annual fight over the question whether the London County Council are to get Parliamentary powers for the construction of a tramway to connect the present main termini on the south side of the Thames by way of Blackfriars Bridge, the Thames Embankment, and Westminster Bridge. Great as would be the benefit of such a line in itself, it would have the enormous further advantage of connecting by a spur with the line in the new subway running from the Embankment northwards to Southampton Row, where a junction is to be made with the northern tramway system. Thus through tramway communication would be established between the south and the north of London. The County Council have repeatedly brought forward the Embankment scheme, the mass of the public demand it, the expert witnesses for the Board of Trade have commended it before the Royal Commission on London Traffic. A hide-bound majority of the City Corporation, however, object to it, and the representatives of wealth and "west-endism" in Parliament, for their own selfish interests, are bitterly opposed to it. In past years the scheme has generally been rejected by the House of Commons; though on one occasion when it got through the ordeal there it was rejected by the House of Lords. At present notice has been given by three members of Parliament that one of them, as opportunity may decide, will move the rejection of the part of the Council's bill authorising this most necessary tramway. The well-known plea that a tramway would destroy the beauties of the Embankment ought in these days to disappear as ludicrous. In the most beautiful streets of the finest cities of Europe, not only do tramways now exist, but tramways using the overhead trolley wire. The Embankment tramway, being on the conduit system, would have no overhead wires. Or, to take a purely British comparison, it will be admitted by everybody that the so-called beauties of the Thames Embankment fade into absolute ugliness before the majesty of Princes Street, Edinburgh. But there has been a tramway along Princes Street since the early days of tramways in this country. It used to be a horse line and it is now worked by cables. Proud as the citizens are of their beautiful city, and particularly of its central gem, Princes Street and its surroundings, it never seems to enter their minds that the whole fair scene is spoiled by the existence of a tramway. Whatever the result of the London County Council's effort this year, the need for the tramway is continually becoming greater, so that time is on the Council's side. They will get their tramway sooner or later, but for the benefit of the public the sooner the better.

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The Importance of Organisation.

Recent events indicate that in the case of some municipal tramways there is room for improvement in the co-ordination of the relations between the various departments. Successful tramway working cannot be obtained unless each officer and each department has its proper place in the organisation of the whole, and unless the business is carried on under a well-known and well-established system. In the first place, it is essential that the relations between the chairman and the chief executive officer should be clearly understood, and each should take care not to infringe the prerogatives of the other. Emergencies may at time demand sudden action from one or the other, but these occasions are few, and the regular routine of business can again be quickly re-established when the emergency has passed. If the duties and responsibilities of the manager be not clearly defined there will almost inevitably be cases of friction, which means useless dissipation of energy and a diminution of the efficiency with which the work of the department is carried on. As Mr. Vreeland, the well-known American street railway manager, recently said in an address before the New York Electrical Society, there are many avenues of expenditure and only one principal source of revenue. An organisation so efficient, departments so well conducted, that each does its full share in providing convenient and up-to-date services for the public is the true measure of success. This result cannot, however, be obtained without the due subordination of the various departments. No matter how great may be the technical skill or experience of individual departmental chiefs, unless their work is so planned that it fits smoothly into the whole scheme of things, their efforts will be largely wasted. Successful operation is made up of many details, and these details must be dealt with almost automatically. When any officer, or any department, is obliged to ask whether certain duties belong to him or to others there is evidence of a loosely organised system. In the best conducted tramways the established order is so well known and so closely adhered to that neither time nor energy is wasted over questions of this kind. To attain such organisation it is necessary, however, that the executive should at the outset be provided with ample power to initiate and to carry out his ideas. He must be able to select his lieutenants and to determine the scope of their authority. Committees who hesitate to grant such power must face the probability that their tramway system will never equal in efficiency others where a more courageous policy has prevailed.

Top-covered Cars on Narrow-Gauge Lines.

The revised regulations which the Board of Trade desire to impose on tramways have met with considerable criticism, as might have been expected. Tramway managers naturally feel that they are sufficiently protected by official regulations at present, and fail to see the necessity for further infliction. On the whole the revised rules are, however, not seriously objectionable in themselves, if the suggestions as to folding steps and the reversed stairway and the prohibition of top-covered cars for 3 ft. 6 in. lines are excepted. Few who have had personal experience of the present folding steps would desire to increase that experience. As regards the top covers on narrow-gauge lines, we think the Board of Trade may safely leave the decision to the manager and engineer of any particular line. The latter know the local circumstances better than departmental officials can possibly do, and as they are immediately responsible for the safe working of the cars they are not in the least likely to run undue risks. If the tramway officials have no hesitation in adopting top covers in any given case, the Board of Trade may safely approve of that course.

LIGHT RAILWAYS BILL, 1905.

The following is the text of the bill to continue and amend the Light Railways Act, which was presented to the House of Commons by Mr. Gerald Balfour on March 2.

1. The powers of the Light Railway Commissioners under the Light Railways Act, 1896 (in this Act referred to as the principal Act), shall continue until Parliament otherwise determine.

2. (1) If any order under the principal Act is not confirmed by the Board of Trade on the ground that the proposals of the promoters ought to be submitted to Parliament in pursuance of sub-section three of section nine of the principal Act, the Board may, if they think fit, submit the proposals to Parliament by bringing in a bill for the confirmation of the order.

(2) If, while a bill confirming any such order is pending in either House of Parliament, a petition is presented against the order, the bill, so far as it relates to the order, may be referred to a select committee, or, if the two Houses of Parliament think fit so to order, to a joint committee of both Houses, and the petitioner shall be allowed to appear and oppose as in the case of private bills.

(3) On bringing in a bill under this section for the confirmation of an order, the Board of Trade shall make a special report to Parliament with respect to the order.

3. This Act may be cited as the Light Railways Act, 1905, and shall be read as one with the principal Act, and the principal Act and the Light Railway Commissioners (Salaries) Act, 1901, and this Act may be cited together as the Light Railways Acts, 1896 to 1905.

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CORRESPONDENCE.

To the Editor of the Tramway and Railway World.

Running Powers.

Sir,—"Twenty years a manager"! What a confession of a mis-spent life of a mind sufficiently infantile to base a so-called criticism on pure assumption, and old enough for ideas sufficiently fossilised to be found a habitat in the British Museum, in company with other specimens of the Pleocene period! Little wonder that at the last moment a touch of modesty has deprived your readers of the name of this gentleman, who is so overburdened with his feeling of responsibilities, coupled with years of anxious management.

My unknown critic, do not despair; unfortunately for progress you are not alone, and like Martha's sister of old, but unlike some others, you have one great virtue—viz., that of modesty—that you shall not be deprived of.

Has my unknown friend never heard of one railway company having compulsory running powers over another, or, in his own language, the use of a line by the carriages, engines, and crews of an alien system? Does he suggest that the guard of the North Western train to the Mansion House suddenly changes, like a chameleon, and becomes impertinent directly he arrives at Earl's Court; or that the passenger by that train is tempting Providence by his recklessness in continuing his journey in that train when it arrives at the point of junction with the District line? Does he suggest that there is anything like the same complication in a through service on a tramcar as exists in a through railway service through complicated junctions, signalling, and so on, at express speeds?

"Tramway Manager," unintentionally no doubt, places me under a great disadvantage by not allowing me to test his capacity as a manager by concealing his identity, but nobody in his senses can but join issue with him when he suggests that a change of car crew is comparable with a change on every trip.

There was a well-known "Twenty years a manager" of a tramway system in the north of England, the owners of which were contemplating electric traction, who went with a deputation to visit the Bristol Electric Tramway system. Before leaving he said to his chairman, "Well, we began with horses and then went to steam, we are now going to electricity, we shall have to go back to horses."

My unknown critic, it is due to the enormous advance in street railway facilities, only possible since the application of electricity, that has developed the public demand for through communication either by compulsion or agreement. While we have enlarged our minds we have outgrown yours. Go back to horses!

Yours faithfully,

Stephen Sellon.

36, Victoria Street, Westminster, S.W.

TRAMWAYS AND LIGHT RAILWAYS RETURN.

Board of Trade Report.

The Annual Board of Trade Return relating to Street and Road Tramways and Light Railways, etc., to an order of the House, of July 22 last year, which was ordered to be printed on August 4 following, has been issued, rather earlier than usual. It covers the period from June 30 to December 31, 1903, in the case of companies and for three months more, *i.e.*, to March 31, 1904, in the case of local authorities, these latter being the dates which appear to be most convenient to the respective undertakers. Great changes can, therefore, not be expected; there is a net additional mileage of 67 m. 56 chs., made up of 203 m. 48 chs. increase in electric traction, and a decrease of 135 m. 72 chs. in other methods—practically all on municipal lines—on which 3½ millions sterling have been spent in the nine months covered by the returns. The most interesting part of the return is the additional information given therein.

In Part I. the heading "capital expended on lines open for traffic" has been expanded into six sub-heads, viz.: (1) Permanent way; (2) electrical equipment of line; (3) electric generating plant or stationary engines; (4) street and road improvement (including purchase of land), so far as necessitated by the tramways or light railway; (5) land (other than that included in preceding column) and buildings; (6) other purposes.

In Part II. the changes are still more important. The heading "general repairs and maintenance" under "working expenditure" has been split into four, viz.: (1) Permanent way; (2) electrical equipment of line; (3) cars and other rolling stock; (4) buildings, fixtures, tools, and miscellaneous equipment.

On the other hand, also under "working expenditure," the following headings disappear, viz.: locomotive (including electric) power; animal power; repairs and renewals of engines; renewals, etc., of horses; repairs and renewals of cars. In place of these appears a new sub-head: "cost of traction power (stating whether based on actual cost of electrical energy produced expressly for the line or on settled prices paid for supply)." "Net receipts," which formerly came under a main heading, are now split up into six sections under "appropriation of net receipts," which, again, is now and, rather curiously, a sub-head under "working expenditure." These sections are: interest or dividend; repayment of debt or sinking funds; other charges (rent of leased lines, etc.); reserve (including depreciation) and renewal funds; relief of rates; balance (carried forward), etc. With regard to this last item, it will be observed that there is no heading for "balance brought forward"; in the prefatory memorandum it is explained how that, in many cases, the columns under "net receipts" will not correspond with municipal or company accounts, as the return "has been restricted to showing the disposal of the net receipts . . . . whereas the accounts would include moneys brought forward from the past year or derived from other sources, or (in the case of local authorities) taken from local funds." It seems a pity that this course should have been taken; the comparisons of balances carried forward from year to year are very useful. Finally, there is one entirely new heading, viz., "quantity of electrical energy used for all purposes chargeable to the undertaking (in B. T. units)"; and the number of cars in stock has been split up into electric and non-electric cars. A very praiseworthy attempt has been made by the Board of Trade to increase the usefulness of their returns, and it must be conceded that the attempt has been successful—in the main.

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The return covers, as mentioned above, the period down to December 31, 1903, in the case of companies, and to March 31, 1904, in respect of local authorities. As compared with the year 1878 the length of line open has increased from 269 miles to 1,840 miles in 1903-4: the capital expenditure from £4,207,350 to £46,451,444; the number of passengers carried from 146,000,000 to 1,799,000,000, and the net receipts from £230,956 to £2,912,110. The following table relates to an electric period, as compared with 1898, which was a maximum steam period, and 1879, which was almost wholly a horse period:

	1879. Horse Period.	1898. Steam Period.	1903-4. Electric Period.
Capital expenditure per mile of single track open:			
Lines and works	£7,840	£7,770	£11,780
All items	£9,877	£10,469	£16,018
Percentage of net receipts to capital outlay	3·97	6·38	6·27
Percentage of working expenditure to gross receipts	83·81	76·93	66·15
Passengers carried per mile of route open	469,641	806,703	977,951
Passengers carried per car mile ..	7·77	9·48	9·23
Average fare per passenger	1·84d.	1·23d.	1·11d.
Amount paid in relief of rates out of profits of undertakings worked by local authorities	(Not applicable.)	(Not given.)	£207,087

The following table shows the lengths worked by various methods of traction:

Method of Traction.	England and Wales.		Scotland.		Ireland.		Total.	
	M.	Ch.	M.	Ch.	M.	Ch.	M.	Ch.
Electric	1,232	30	140	7	89	44	1,462	1
Steam	75	53			33	5	108	58
Cable	8	67	21	3	—		29	70
Gas motors	4	2	—		—		4	2
Horse	177	5	18	2	40	15	235	22
Total	1,497	77	179	12	162	64	1,839	73

The undertakings are divided between local authorities and private companies, as shown in the following statement:

	Total Expenditure.	Length.		Number of Undertakings.
	£	M.	Ch.	
Local authorities	*28,060,524	1,147	59	162
Companies	†18,390,920	692	14	150
Total	46,451,444	1,839	73	312

* These figures include, in several cases, the amounts expended by the lessees of local authorities on buildings and equipment for working the lines.

† These figures include cost of buildings and equipment in respect of certain local authorities' lines worked in conjunction with other lines.

MR. CLIFTON ROBINSON ON THE MOTOR 'BUS.

The London United Electric Tramways Company are just completing the details and contracts for one of the biggest tramway schemes yet attempted in this country, involving the construction of more than thirty miles of track in the county of Surrey. The work which will involve the outlay of fully £700,000, will be given out in a few days. "That," remarked Mr. Robinson to a representative of the press, "is the best evidence of our faith in tramways, against which the motor 'bus can never compete." Asked what were his views wtth regard to the motor omnibus, Mr Robinson replied: "As against an electric car it has about the relative value of a perambulator. To work an electric tramcar costs 6d. per mile; to work a motor 'bus costs 1s. The life of a motor is not more than two years, whilst that of an electric car is 14 years. The electric car will carry 70 passengers and the motor 'bus only 32. The motor 'bus cannot pay under such conditions; its margin of profit leaves nothing to speak of for reserve. Our extra earning capacity will more than cover the initial cost of the track and its maintenance"

THE PRODUCTION OF ELECTRICAL POWER.

A Popular Explanation of Methods Employed.

IX.

The Electric Circuit.*

In order efficiently to utilise the electrical energy developed by the dynamos for electric traction very many accessories must be used, and a brief description of the most important of these may now be given. Deferring for the moment the study of the various classes of indicating and measuring instruments used on the power-station switchboard, let us get a general idea of the way the current is led to and from the motors employed to propel the cars on an ordinary tramway. Copper conductors are connected to the terminals of the dynamo, and these pass to the switchboard from which are led the cables or conductors that convey the current from the power-station to the tramway route. The cables or feeders are generally placed underground, and it is therefore essential that they shall be surrounded by non-conducting material to insulate them from the earth. The cables universally used are made up not of one thick copper wire covered with insulating material, but of a considerable number of copper conductors arranged in some systematic way and insulated by means of paper, jute, rubber, gutta-percha and other insulating materials. The insulating material again is protected by means of an external covering of lead. It is usual further to protect the cables from the chemical action of acids or gases in the soil by placing them in stoneware or earthenware ducts or in troughs. Where troughs are used the inside space around the cable is filled in solid with bitumen, etc., which serves to keep water from affecting the cables. In many cases rectangular stoneware conduits are employed, and these are built in Portland cement mortar, so as to form a solid structure. The cables are drawn through the conduits after the latter are fixed in position.

Various factors have to be taken into account in deciding what size of cable it is best to use in any particular case. The engineer must consider the initial cost of the cable, and this depends largely upon the amount of copper used in its construction and upon the price of copper at the time. He must not make the cable too small, otherwise it will be liable to be damaged by being made hot at times when large quantities of electricity are required. It will be remembered that the amount of heat developed in a conductor varies as its resistance, and the smaller the cross section of the copper in the cable the greater is its resistance. The resistance of the cable depends also on the quality of the copper. For the manufacture of cables practically pure copper is employed, as pure copper conducts much better than when it contains impurities.

Again the amount of heat developed in the cable represents so much lost energy. The cable, however, must not be made too thick or the initial cost becomes great. Lord Kelvin has shown that the most economical size of cable is such that the interest on the first cost of the cable and the depreciation allowance should equal the cost of the energy lost in the cable per annum. On a large tramway system, feeders of several sizes leave the power-station to feed different portions of the tramway system, and these vary in size according to the distance to be traversed and the number of cars to be supplied with energy.

The overhead conductor is also usually of copper, but in this case it consists of a single bare wire. This wire

* The eighth article appeared in the Tramway and Railway World of September 8, 1904.

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is supported above the track by means of poles and brackets, or by span wires running across the track from poles placed on the roadside or from the buildings lining the route. The poles used for supporting this conductor, or trolley wire as it is called, are generally made up of several sections of strong iron or steel tube shrunk together and forming a pole about 30 ft. long. The poles vary in weight from about 700 lbs. to about 1,200 lbs. The brackets are placed at right angles to the pole, and are generally of such a length as to allow the trolley wire to be supported above the track, although considerable variations in the position of the wire are permissible.

At the poles the trolley wire is soldered to clamps which are insulated from the supporting brackets by some insulating material. Insulating materials as a rule will not stand large tensile stresses, and the insulating material used is therefore placed in such a position that it is in compression. A simple way of accomplishing this is to screw the clamp to a bolt covered with hard insulating material, and to support the bolt from a casting, insulating material being placed round the underside of the head of the bolt.

To comply with the Board of Trade regulations, the trolley wire must not be continuous, but must be broken up into sections. It is therefore usual to put up the wire in half-mile sections, which are insulated from each other. The ends of the wires are joined to section insulators. Between the ends of the insulator is placed a strip of lignum vitæ or other hard wood to serve as a runner. In some cases the wood strip is protected by a number of bronze sections or teeth to withstand the wear of the trolley pulley.

It is at these section insulators that the trolley wire is connected to the feeders bringing the current from the power-station. Feeder pillars are provided at these points, and here a connecting cable is joined to the feeder. This cable is insulated with vulcanised rubber, lead covered, and braided. It is led from the pillar through a draw-in box at the foot of the pole, and passes up the interior of the pole, emerging at about the level of the trolley wire, and is then carried along the bracket arm. A copper ferrule is sweated on to the end and clamped into the section insulator. Fuses are placed inside the feeder pillars as a safeguard in case of the current becoming abnormally great through accidents. Arrangements are also made in these pillars so that any section of the trolley wire can be isolated from the rest of the system.

Since the trolley wires are liable to be struck by lightning, it is necessary to provide protection for them. This is done by means of special fuses called "lightning arresters." The fuses in these arresters are so arranged that when the lightning strikes, the current passes across a small gap between two fuse wires insulated from each other, and burns out the wire. When this occurs, a little ball falls on to the end of the next fuse and the arrester is ready to deal with another discharge. In another form of arrester a small air gap is provided, and when the lightning strikes, the current flows for a moment to the earth. When it does so, however, it excites an electric magnet which causes the arc flame between the terminals to be blown out. Lightning arresters are placed on the cars, on the poles, and in the power-station.

When it is required to use a car on the tramway, contact must be made with the trolley wire overhead. A pulley fixed in a suitable mounting is employed to run along the trolley wire. In what is called the swivelling trolley, the pulley is so mounted that it can turn easily and accommodate itself to the direction of the trolley wire. The trolley head is supported on a long arm known as the trolley pole. The latter is supported by a standard on the top of the car in such a way that it can turn in any direction. A spring in this standard actuates the trolley pole, causing the trolley pulley to press firmly against the trolley wire. The current collected by the pulley passes down a cable in the trolley pole, down the standard, through the driver's controlling apparatus to the motors beneath the car. Two motors are usually employed on each car, and these can be used in series or parallel as required. The current actuates the motors as already described, and then passes through the axle and wheels of the car to the track rails beneath. The current is conveyed by the rails back to the power-station.

Now since the rails are not insulated from the earth there is a certain amount of leakage from the rails to the earth. The greater the difference in potential between the rails and the earth the greater is the leakage. Any considerable leakage is objectionable, not only because it represents a dead loss, but also because it is liable to cause trouble through electrolysis. Gas and water mains have frequently suffered from this cause. Evidently then it is necessary to minimise this leakage as much as possible, and the best and simplest way is to reduce the electrical resistance of the track as much as possible. The resistance of the steel rails themselves is comparatively low, but trouble is often experienced through the resistance offered at the points where the rails are joined together. Good electrical contact can not be ensured by fastening the rails together by fish-plates and bolts, and the usual practice is to connect the ends of the rails together by means of short lengths of copper wire or cable. These copper connectors are known as rail bonds, and various good types are in common use. The great difficulty experienced is in securing good and permanent contact between the copper bond and the steel rail. Unless the joints are very well made trouble results sooner or later. One method of getting good contact is to provide a hollow lug on the bond. This lug is inserted into a hole in the rail, and then the lug is expanded by driving into it a tapered steel plug. Sometimes the bond is placed underneath the fishplate for protection. Not only are the rails connected up in this way, but bonds are also placed across the track from one line of rails to the other, so that the whole track serves as one conductor carrying the current back to the power-station.

The fall in voltage between the ends of the rails is tested regularly and any defects made good, and the Board of Trade has power to insist on the fall in potential along the rails being kept within certain limits. In speaking of the current passing from the trolley pole above the car to the motors beneath, mention was made of the fact that the current passed through the driver's controlling apparatus. This controller, as it is called, is really a complicated form of switch. Although the construction of the controller itself is somewhat intricate, the method of using it is quite simple. Tramway motors are usually series wound, but when two are used on the same car they are not always used in series with each other. They are both connected with the controller, and an extra resistance is also connected therewith. These are worked on a system called the series-parallel control. The method of working is first to place the two motors and the resistance in series. Then when the car is started the resistance is cut out so that the motors are in series alone between the trolley wire and the track. When it is desired to put the motors in parallel with each other the resistance is again first introduced, the motors connected in parallel, and the resistance again cut out. The controller has a handle on the top, which operates a steel spindle carrying a large number of contacts, that make connection with corresponding terminals according to the position of the handle. A series of notches are provided on the top of the

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controller to which the handle may be brought. When the handle is on notch 1 the motors and resistance are in series with each other. When placed at notches 2 and 3 the motors are still in series, but the resistance is cut down to one third and one twelfth of its value respectively. At notch 4 the resistance is entirely cut out and the motors are in series alone. This position gives one of the working speeds for the car. At notch 5 the fields of the motors are shunted, and one motor together with one third the resistance is placed in circuit. This gives another speed. At notch 6 the second motor is placed in parallel with the first, the resistance still remaining. Another speed is thus available. At notch 7 the resistance is reduced to one twelfth, and at notch 8 the resistance is cut out. At notch 9 the motors are in parallel and their fields shunted. Thus a variety of speeds are attainable. Notches 8 and 9 are only used for going up hill, and for very high speeds.

NEW YORK AND LONDON TRAMWAYS COMPARED.

The London County Council have issued the following interesting memorandum by Mr. J. Allen Baker, chairman of the Highways Committee, on the working of the New York conduit electric tramways. Mr. Baker, it will be remembered, was recently in New York on the occasion of the completion of the Rapid Transit Subway:

In compliance with the request of the Committee, I have pleasure in submitting the following particulars with regard to the working of the conduit system of tramways in the city of New York. No other system of mechanical traction is now allowed on Manhattan Island (New York proper), but the overhead system still prevails in Brooklyn and the outlying districts north of Manhattan, and also in Jersey City. Both the cable and the trolley lines within the city have been converted to electric conduit, and also many of the "cross town" horse lines. The original cost of constructing the Broadway cable lines was £100,000 per mile of single track. A considerable number of horse lines still exist, but many of these are now under reconstruction.

Originally there were over 40 independent street car companies in New York, but now the entire system is operated by "The New York City Street Railway Company," which has absorbed "The Metropolitan Street Railway Company," "The Third Avenue Company," and the other smaller companies.

The lines traverse the most densely populated districts, and the traffic and earnings exceed those of any other street railways in the world. The first conduit line, three miles in length, was laid in Lennox Avenue in 1894, and it proved so efficient, reliable, and economical in operation, that the extension of the electric conduit system was decided on, not only for all new lines, but also in place of the cable system, in comparison with which it showed an economy in operation of at least five cents per car mile. No printed report is published by the Company, but the chief engineer, Mr. M. G. Starrett, very kindly furnished me with particulars of the working of the lines during the last financial year. Some of these, in comparison with corresponding figures on the Council's South London conduit lines will, I think, be of interest to the Committee.

In all there are now 210 miles (counted as single track) of conduit lines in New York, compared with the 185 miles of tramways (also counted as single track) in the county of London, of which 156 miles are owned by the Council, while 29 miles still remain to be purchased, the last falling in in 1911.

A universal five cent fare (2½d.) is charged, but as the transfer system prevails (entitling a passenger by the payment of one fare to a continuous ride over two or more lines) so large a proportion of passengers take advantage of it that the average fare per journey is reduced to 3¼ cents, or very slightly more than 1½d. A single fare under this system may be made available for a distance of 15 miles. The Council's highest fare is 3d., for a distance of 6½ miles, and the lowest ½d., for a maximum ride of about a mile, the average distance for a halfpenny fare being two-thirds of a mile. Moreover, a system of workmen's tickets peculiar to London is in force, the charge being 1d. per single journey for any distance, and 2d. for a return journey, the return ticket being available on the same day. This privilege is very extensively used. The average fare on the Council's tramways is, for these reasons, thus only about ·93d.

In New York the average speed on all the lines is 10 miles per hour, the great amount of traffic on Lower Broadway and many of the down town "cross lines" tending to bring down the average. For those streets even a less speed is attained than is possible in the case of the busiest thoroughfares traversed by the Council's electric lines, whereas on the more open "up town" streets a higher speed is attained than is permitted by the Board of Trade in London. The average of 10 miles in New York compares with an average of about 8 miles in London.

On the Broadway, Fourth Avenue, and some other lines a headway of 15 to 20 seconds is maintained for several hours in the busy part of the day. Both of the lines specially mentioned are intersected in the city by very busy lateral thoroughfares, and pass, for some portion of their route through streets so narrow that vehicles standing by the kerb have to be passed with great care. The result is that a large number of accidents occur, especially collisions with vehicles, and the amount and nature of the claims on account of accidents are greater, in proportion to population and mileage, than is the case in London.

The following figures with regard to the earning power, etc., of the new York lines, are important:

The average earning power per car mile is from 33 to 34 cents, or 1s. 4½d. to 1s. 5d. (dollar at 4s. 2d.)

The operating cost (including maintenance, repairs, renewals, accidents, etc.) per car mile is from 14 to 15 cents, or 7d. to 7½d., making a net profit per car mile, of about 19 cents, or 9¼d.

The Company has about 3,000 cars in use, all single deck, but many of these are open or "summer" cars.

An average of 1,600 cars were in daily operation during the year under review, and 52,014,109 car miles were run; this mileage, for the 210 miles of track in use, at 19 cents, gives a profit for the year of $9,882,680 (say £2,058,892), an average of £9,804 per mile of single line.

The cost of construction of the New York conduit lines averaged from $100,000 to $125,000 per mile of single track; this cost, including all the conduit work, tracks, earthenware ducts for the feeder cables (but not the feeder-cables themselves), works out at an average of about £22,500 per mile, as compared with £13,800 per mile of single line, the average cost in the case of the South London conduit construction, plus £1,000 extra for the earthenware feeder-cable ducts, making £14,800, as compared with £22,500 in New York.

The cost per single mile of the feeder-cables used on the New York system is about $16,000 (that is practically £3,200 per mile of single track, as compared with £1,500 in London).

The power-stations and sub-stations, together with their equipment, cost per mile of conduit line installed,

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about $29,000 (that is about £5,800, as compared with the estimated cost for London of about £5,850). This comparison is indicated in the table included later in this report.

The cost of cleaning the conduit averages $500 per mile of single track (say £100), compared with £134 per mile included in the estimates for the Council's tramways for the current year; 160 men are employed for conduit cleaning in New York on the 210 miles of track.

Scrapers are used to carry away the dirt in the conduits between the manholes, and no caked mud is allowed to accumulate at the bottom of the conduit. The insulation holes are placed 15 feet apart, and through these the cleaners clean out the conduit daily as well as through the manholes, or sumps, which are placed 100 feet apart. One of the greatest difficulties experienced in New York is the maintenance of the service during the severe winter weather, when snow may accumulate and ice freeze at the bottom of the conduit. Further, in times of very severe frost, an occasional difficulty has been experienced in straight track work, the track rails being forced inwards, and in their turn forcing the slot rails inwards, and so decreasing the width of the slot opening along which the plough passes. These are difficulties which are not likely to occur in London. Mr. Starrett expressed the opinion that the climatic conditions of London are much more favourable than those of New York for the operation of conduit tramways.

Notwithstanding these special difficulties, the "trouble" items on the conduit lines are considered to be no greater (if as great) as on the trolley lines outside the City limits, while the operating expenses, including maintenance, repairs, and renewals, when the greater life of the conduit work is taken into account, is considered to be in favour of the conduit system.

In New York the day's work of motormen and conductors consists of 10 hours' labour out of 12 consecutive hours. The motormen receive a minimum wage of $2.10, and a maximum wage of $2.50 per day for a full day's work. For the first year $2.10 (8s. 8d.); for the second year $2.25 (9s. 4d.); for the third year $2.35 (9s. 9d.); and for the fourth and fifth, and after the fifth year, $2.50 per day (10s. 4d.). The rates of pay of the conductors are as follows: First year, $2 (8s. 3d.); second year $2.10 (8s. 8d.); third year $2.20 (9s. 1d.); and after the fifth year $2.32 (9s. 9d.).

Conduit cleaners are paid $1.75 (7s. 2d.) for 10 hours' work.

Car cleaners receive from $1.50 to $1.75 (6s. 2d. to 7s. 2d.) for a day of 10 hours, according to their work and length of service; they are supposed to work seven days per week, but in practice every man is off duty on alternate Sundays.

The greatest care is exercised in the selection of the motormen, as the safe and economical working of the system depends on their skill and efficiency. Every applicant has to pass a severe examination, including tests for eyesight, hearing, and colour blindness. After an examination for this purpose he enters the "school," and upon the certificate of the "instructor" he is first placed upon streets having the least traffic until he is considered competent to take charge of a car on a more crowded street. Of the men who pass the physical examination, only about 40 per cent. finally qualify as first class men. Neither motormen nor conductors are permitted to sit while on duty on the cars. This is also the rule in all the large American and Canadian cities. It is not considered possible for the motorman to operate electric cars with safety in town traffic unless he is in a standing position.

TABLE OF COMPARISON BETWEEN THE NEW YORK AND LONDON COUNTY COUNCIL CONDUIT SYSTEMS.

	New York. 210 miles (single track).	London. 54 miles (single track).
Average gross earnings per car mile	1s. 4½d.	1s.
Average operating cost per car mile, including repairs, renewals and reconstruction, maintenance, accidents, &c.	7½d.	Estimate without renewals, 7d.
Average cost per track mile for conduit cleaning per annum.	£100	Estimate for current year, £134
Average cost of constructing conduit line per mile of single track, including cable ducts but not cables.	£20,000 to £25,000	£14,800
Average cost of feeder cables per mile of single track.	£3,200	£1,500
Cost of power-station and sub-stations per mile of single track.	£5,800	£5,850*
Average speed at which cars run..	10 miles an hour	8 miles an hour
Hours of motor-men and conductors	10 hours' labour (in 12 consecutive hours)	10 hours' labour (in 12½ hours average)
Pay of motor-men per day.. ..	8s. 8d. to 10s. 4d.	4s. 9d. to 6s. 3d. (74 per cent. at 6s. 3d.)
Pay of conductors, ditto	8s. 3d. to 9s. 9d.	4s. 9d. to 6s. 3d. (65 per cent. at 6s. 3d).
Pay of conduit cleaners, ditto ..	7s. 2d.	5s. 4d.
Pay of car cleaners per week ..	£2 3s. 5d. to £2 10s. 6d.	£1 5s. to £1 7s. 6d.

* This figure is based upon obtaining power from the Greenwich generating station, and with 1,000 cars in operation over 200 miles of single track.

It will thus be seen that the constructional costs in New York are about 50 per cent higher than in the case of the Council's tramways, this being probably accounted for by the facts (i.) That some portions of the conduits had to be excavated through solid rock; (ii.) that an extended and more expensive form of yoke is used than in London; (iii.) that all labour and material are dearer in New York than in London; and (iv.) that the pipe obstructions are greater than those met with in the reconstruction of the Council's lines.

It will be noted that under the head of "cost of operation" in New York, the figure of 7½d. per car mile includes all renewals and reconstruction of lines, rolling stock, etc., and no sum has therefore to be set aside for this purpose.

On the Council's lines the present estimates (with labour 50 per cent. lower than New York) show an operating cost from the Greenwich station of 7d. per car mile, and it is also proposed to set aside a further 1d. per car mile as a "Renewal Reserve Fund."

Among the important advantages in a city like New York of the conduit over the trolley are considered to be (1) the greater sightliness; (2) the absence of danger from live wires in the streets; (3) immunity from danger of electrolysis to water and gas mains, owing to insinulated conductor bars in the conduit, instead of rail returns as in the case of the trolley system; (4) greater durability of construction, the conductors and insulators in the tube lasting probably 30 years as compared with three or four years for overhead wires; (5) no loss of currents by bad contacts, greasy rails, or imperfect bonding of rails, and, consequently, no disturbance to observatories where magnetic observations are carried on.

The comparisons with the New York "cost of operation," and "life of plant," etc., are of more value to London than the earnings; the average fare being so much higher in New York than in London and other special circumstances as above indicated operating.

At the same time it shows with what remarkable economy a complete conduit system in a large city like New York can be operated, and indicates that a slight readjustment of the Council's present fares, or the stages now given for ½d. or 1d. fare, would add materially to the earning power of the lines.

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HALFPENNY FARES QUESTION AT LIVERPOOL.

Mr. Bellamy's Report.

Mr. C. R. Bellamy, general manager of Liverpool Corporation Tramways, recently prepared and submitted to the Tramways Committee of Liverpool Town Council a report on halfpenny fares. Mr. Bellamy's conclusions are in general accord with the opinion often expressed in these pages, that, while there may be exceptions, halfpenny fares are generally a mistake. As far as Liverpool is concerned, he is strongly of the opinion that the introduction of halfpenny fares would seriously jeopardise the commercial stability of the undertaking. In view of this report it seems likely that the last has now been heard of the agitation for halfpenny fares in Liverpool. Considering the long penny stages, and the great convenience of the tramway service, the public have nothing to complain of, and we doubt whether the plea for halfpenny fares is, after all, a serious one.

We append an abstract of Mr. Bellamy's report:

Present Fares at Liverpool.

The system of penny stages at present in operation in Liverpool has given general satisfaction, and has the following advantages:

(1) Of being readily understood.
(2) Of being the least anomalous of all systems.
(3) It reduces the ticket issue and checking to a minimum under a stage system.

While it is exceedingly difficult to provide satisfactory stages of uniform length over routes of varying mileage, it has been nearly accomplished in Liverpool, as shown by the figures relating to the 74 penny stages at present in operation in this city. Excluding seven stages exceptionally short or long owing to unavoidable causes, the maximum length of the penny stage is 2 miles 1,697 yards, the minimum 2 miles 37 yards, and the average length 2 miles 671 yards.

The Ideal System.

The ideal system would doubtless be one which permitted passengers to travel a fixed distance from the point of boarding the car, but the difficulties surrounding the adoption of such a method in connection with ticket issue and checking appear insurmountable at present. When it is borne in mind that only 10 per cent. of the total passengers pay a twopenny fare, which warrants the assumption that probably 75 per cent. of the passengers reside within the old city boundary, or two miles from the centre of the city, it will be seen at once that were the suggested panacea for all anomalies—viz., a universal penny fare—introduced, there would be serious risk of the vast majority of the citizens claiming either that they were being improperly charged a large proportion of the cost of carrying the long-distance passengers, or that they should be carried at a proportionate rate for the two miles they travel, against the four to twelve miles that has been suggested. In any consideration of the question of a universal penny fare, it should be borne in mind that its introduction would principally benefit dwellers in the added areas, and that only 11 per cent. of the total passengers pay more than a penny fare. Further, it might be urged that the long-distance traveller, in addition to being carried at the same mileage rate as on the shorter journeys, with a denser and better paying traffic, enjoys the advantages of residing in more healthful surroundings with a lower relative rental, and generally, in Liverpool, with preferential rating. In pursuance of the principle that a wider distribution of the inhabitants in large cities and towns is desirable, it is important that long-distance passengers should be specially considered. This has been fully borne in mind in maintaining the mileage rate between the centre and the outskirts of the city. The extent to which this can be done must always be governed by the unit fare and stage.

In Liverpool, with a penny stage averaging 2¼ miles, it has been shown to be commercially sound to carry passengers over the whole route lengths at that rate, but the general manager is unable to accept the responsibility of advising the Committee to further increase the facilities at present afforded to the long-distance passenger

Comparisons with Glasgow, Sheffield, and London.

The extent to which the balancing of stages and the financial stability of the undertaking would be affected by the introduction of halfpenny stages is a very important subject, requiring most careful consideration. Of the 55 municipal tramway undertakings, eight have halfpenny fares in operation over the whole system, and nine others have adopted this fare on certain of their stages. It is clear that in a number of instances, due to local considerations, it may be desirable to introduce halfpenny stages over certain portions of the system, just as was done in the case of Liverpool before the Dingle cars were taken to the Pier Head. The average length of the penny stage on the London County Council Electric Tramways is 1 mile 1,537 yards, or 21 per cent. less than that of Liverpool, while the average length of the halfpenny stage is 1,155 yards, being the longest in the country. These stages, notwithstanding the density of the London traffic, are not yet shown to be financially successful, and, therefore, only Glasgow and Sheffield remain for comparative investigation. In both these instances the average length of the penny stage approximates to that of Liverpool, being about 2¼ miles in length, and they have a general system of half-mile halfpenny stages.

There appears to be no doubt that in both these cities the halfpenny stage has increased the number of passengers and the revenue, but the precise extent of the increase is somewhat in doubt. The passengers carried per car-mile are in Glasgow 11·69, Sheffield 10·65, Liverpool 9·63. It would not be at all fair to assume that the difference between Liverpool and the other two cities is entirely due to the existence of halfpenny stages. The peculiar conditions existing in Liverpool must be borne in mind, under which residents on the Cheshire side largely walk between the Pier Head and the business centre of the city; these probably forming a large proportion of the 36 million people annually crossing the river, are lost to Liverpool traffic. In Glasgow and Sheffield the routes radiate in every direction from the business centre, offering a wider field for short-distance passengers. Taking the difference between the passengers carried per car-mile in Liverpool and the average of Sheffield and Glasgow at 15½ per cent., it would not be safe to assume that more than 8 per cent. of the excess was due to the halfpenny stage, which would represent about 9¼ million passengers on last year's Liverpool traffic returns. If the halfpenny stage could be limited to half a mile, there might be some argument in favour of its introduction, but it seems clear, as a result of carefully observing the operation of these stages in both cities referred to, that the ever-growing demand for the approximation of the halfpenny stage, in point of length to that of the penny stage as in London, will be irresistible. It has been made clear that the elongation of the halfpenny stage in Glasgow would very seriously affect the tramway revenue in that city, and increase the difficulties already existing of the short-distance crowding out the long-distance passenger. Therefore, the demands of the halfpenny passenger have not so far been met, but the claim is very urgent, and in Sheffield the same conditions obtain.

Probable Effect of Halfpenny Fares at Liverpool.

It is, therefore, desirable that the Committee should consider the effect of halfpenny one-mile stages in Liverpool. For this purpose a census has been taken of the distance travelled by each passenger on a typical route over a fairly representative period. It was found that of the 91 per cent. of penny passengers, 30 per cent. rode less than one mile, and 30 per cent. less than 1½ miles. Of the latter, it is fair to assume that with one-mile stages at least half the passengers in that group would take advantage of them by walking to the mile limit. It may, therefore, be reasonably calculated that under such stages 45 per cent. of the present penny passengers would pay halfpenny fares. On the present revenue this would mean a reduction of £95,000 per annum. To provide for this loss of revenue, at least 45 millions additional halfpenny passengers would be necessary against 9¼ millions which it is assumed would be obtained. There would, therefore, be a deficit of nearly 36 million passengers, representing a loss in revenue of £75,000. To put the case most favourably for halfpenny fares, and assuming that in Liverpool the traffic figures would rise to those of Glasgow, there would be an increase of 23 million passengers, which would leave a deficit of 22 million passengers, representing a loss of revenue of £45,800, which would further be increased by about 20 per cent. in the operating charges due to the increased number of passengers, amounting to £68,000; and seeing that the service would also require to be increased by 20 per cent., involving the addition of 80 cars, there would be a further capital expenditure of £44,000, which would increase the interest and sinking fund charge to the extent of £2,640. Whether the addition of 20 per cent. in the cars running over the already congested lines in the centre of the city could be safely provided for is an open question, and the Committee might at once be involved in the problem of providing additional central lines.

The General Manager's Warning.

Having regard to all these considerations, the general manager is strongly of opinion that the introduction of such halfpenny stages would seriously jeopardise the commercial stability of the undertaking. The only change that could be usefully and safely recommended, in the light of our own experience and that of other towns, would be the institution of a threehalfpenny stage, which would accommodate the outside residents requiring to travel only partly into the centre of the city, and the passenger travelling outwards requiring to go only a short distance into the suburbs, or *vice versa*. It is probable that a large number of these passengers at present walk to or from the penny stage ending, and possibly a mile for an additional halfpenny added to the principal existing trunk stages would accommodate a large number of citizens, and add to the revenue.

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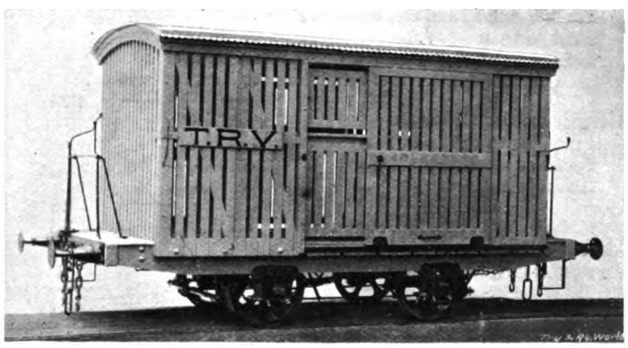
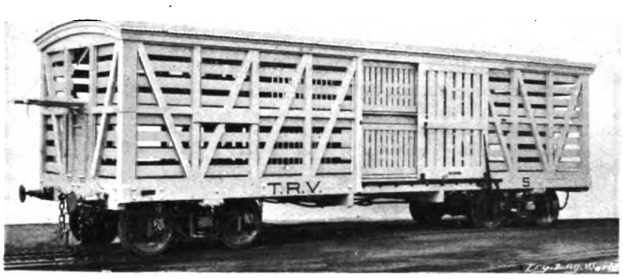
LIGHT RAILWAY GOODS CARS FOR THE ARGENTINE.

The growth in population of Buenos Aires and its environs has been enormous during the last few years. The city is the largest in South America, and is among the first shipping ports of the world. Its population numbers close to a million, and the character of its commercial and social conditions is distinctly modern in every respect, requiring the



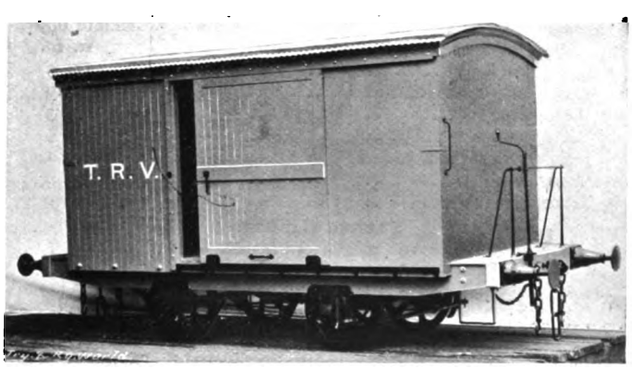
best transport facilities. The "Tramway Rural a Vapor" is about to change its motive power from steam to electricity to enable the handling of a large number of cars on short headway. The rolling stock of the system has been chiefly furnished by the Brill Company, of Philadelphia, which has recently completed an order for the Tramway Rural a Vapor, Argentine, for 122 goods, sheep and poultry cars of the types illustrated below.

The railway extends from Buenos Aires in a westerly direction through a level country, a distance of twenty-two miles. The country



traversed is thickly populated, and has a number of large towns, and the farms of this section supply the markets of the city. For many years a considerable business has been done by the lines carrying goods, cattle, and produce, in addition to the regular passenger service.

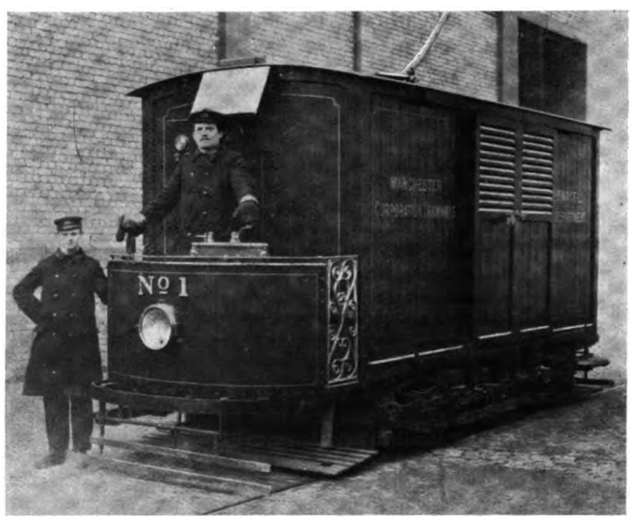
Of the 122 goods cars recently shipped by the Brill Company fifty are 17 ft. box cars; fifty are 14 ft. in length and similar in appearance to the 17 ft. cars; six are 14 ft in length and arranged for carrying poultry; ten are 30 ft. in length and are for carrying sheep; and six 16 ft. cars are for luggage. All have sliding doors at the sides, and



with the exception of the double-truck cars, have short platforms at either end on which spring buffers are mounted. The poultry and sheep cars are arranged with two decks. The longer cars are carried on diamond-frame iron goods trucks, and the shorter on gear trucks, all of the Brill Company's manufacture. This Company has built a large number of cars of these and similar types for railways, plantation lines, and other industrial purposes, and it has also supplied many electric locomotives used in such services.

MANCHESTER PARCELS CARS.

The Manchester Corporation tramways have recently begun a parcels service. Mr. J. M. McElroy, the general manager, has gone thoroughly into the matter, and the service has been organised in such a way that the business can be handled with convenience and despatch. In most cases where tramway companies have undertaken parcels service, the parcels have been carried upon the car platforms, but in Manchester special vans have been constructed for the service. One



of these we illustrate below. These parcels cars are 12 ft. long and 6 ft. wide. They are equipped with motors and controllers in the same way as an electric car, and are lighted with incandescent lamps. The interior is fitted with hooks and movable shelves, for facilitating the handling and distribution of parcels. The sliding doors are of the venetian pattern for the purposes of ventilation. It is not intended to run these cars in accordance with any prescribed schedule, but they will be sent out as required by the traffic to various parts of the system.

LIGHT RAILWAY APPEAL.

CAMPBELTOWN AND MACHRIHANISH LIGHT RAILWAY ORDER.

On February 22 Sir Herbert Jekyll, at the Board of Trade Offices, heard objections to the confirmation of this Order, which was before the Light Railway Commissioners in May last. The line is about six miles in length, and the route is partly on private land and partly on public roads. Its gauge is 2 ft. 3 in.

Mr. G. G. Hawkins (Grahame, Currey, and Spens) appeared for the promoters, with Mr. Galloway, the engineer to the Company. Mr. Kennedy appeared for the Corporation of Campbeltown, and Captain Duncan Stewart, the owner of land on the route, opposed on clauses. There was no objection to the preamble.

Mr. Kennedy said the Corporation of Campbeltown supported the scheme most cordially, but they wanted certain amendments by way of protection to the public. There was a level crossing on the high road near the burgh of Campbeltown. Here there was a good deal of traffic, and the Corporation desired to have the gates closed across the railway.

Sir H. Jekyll: We have had no notice of this objection.

Mr. Hawkins: And it would be contrary to the agreement with the Corporation. It is left to the Board of Trade to direct what is to be done or to approve it.

Sir H. Jekyll: Where the public safety is concerned our Inspecting Officer will see to that.

Mr. Kennedy: Of course, I have confidence in your inspecting officer, but I am instructed by a Highland Corporation, you know. I won't say anything more.

Captain Stewart raised objection to a wall being removed on his estate which would interfere with the amenities of his property, and reduce its value by between £2,000 and £3,000.

Mr. Hawkins: We scheduled the land in the first place as belonging to the Duke of Argyll, but we now give Captain Stewart assurance that we will not take his land without his consent.

Captain Stewart; I will interdict you if you do.

Sir H. Jekyll: You may be satisfied that your land cannot be touched without your consent.

Captain Stewart: I thought they might have the Order altered so as to take it, but I would interdict them if they took an inch of it without my consent.

Sir H. Jekyll: We will communicate further with the parties. At any rate, the public will be sufficiently protected as regards safety by our inspecting officer.

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WOLVERHAMPTON & MOTOR OMNIBUSES.

Optimistic Estimates.

The Wolverhampton Tramways Committee have for some time had under consideration the question of constructing an electric tramway from the centre of the town to the Penn district, but they have come to the conclusion that, owing to the narrowness of the roads and the heavy expense, it would be better to place a service of motor omnibuses on the roads, and at a meeting of the Town Council on Monday, February 13, the Committee recommended that tenders be obtained for three double-deck petrol omnibuses at a cost of about £950 per 'bus; the vehicles to be provided with 30 H.P. petrol engines, capable of a maximum speed of 14 miles per hour, and the seating capacity to be 16 passengers inside, 18 on the roof, and two in addition to the driver. Alderman Mander, in introducing the report, said the figures (estimates of capital and working costs) contained therein had been rather exaggerated than otherwise. Motor 'buses were largely in use in Birmingham and elsewhere. Alderman Craddock said the Committee had not lost faith in the efficiency of the Lorain tramways, but a permanent track would involve considerable danger and inconvenience. With regard to the cost, if the report were adopted he thought the Committee would be lucky if they made both ends meet. The report, however, pledged the Council only to an expenditure of £3,050, as against £17,455 for a tramway. After further discussion, it was agreed that the further consideration of the subject should be adjourned for a month. The report of the Committee contains figures of considerable interest, and we give it in full below. Alderman Mander's remark that the figures have been exaggerated may be taken to mean that the Committee have increased the figures given to them by the makers of motor omnibuses, but judging by the actual performance of these machines up to the present time, we think the Committee will be exceedingly fortunate if they obtain motor omnibuses that will work at anything less than 21 per cent. increase on their estimates.

The following is the report of the Tramways Committee which was presented to the Council:

Your committee have for some months past had under consideration the provision of improved means of transit for the residents in Lea Road and Penn Fields district. There are two methods by which the needs of this particular district may be served, *i.e.*:

(1) By the construction of an additional tramway down Victoria Street, Worcester Street, and Lea Road, to the borough boundary.

(2) By the provision of a service of motor omnibuses.

The first of these proposals is beset by many difficulties, as owing to the non-removal of property in Queen Square, and to the extreme narrowness of the roadway in Worcester Street, the construction of a tramway would involve considerable danger and inconvenience to vehicular traffic along those streets, and to the tradesmen who have premises therein. Also, it is more than doubtful whether there is a sufficient traffic to be obtained on the Lea Road to justify the heavy capital expemditure which the construction of a tramway would necessarily involve.

Motor Omnibuses.

Rapid strides have been made during the past two or three years towards the perfecting of the motor omnibus as a vehicle for public service, and the experience of private companies in many towns shows that a standard design of motor omnibus may be relied upon to give an efficient and rapid service at a reasonable cost.

The principal advantages of this type of vehicle are:

(1) The capital expenditure is very much smaller than must be incurred with any system of tramways.

(2) There is no initial disturbance of the streets and footways.

(3) A better average pace is maintained, owing to the fact that the vehicles are not delayed by other traffic on the road.

On the other hand, the seating accommodation provided is not so large as that of a double-deck tramcar, and consequently its ability for dealing with rush traffic is somewhat limited.

Comparative Capital Cost of the Two Methods.

The total inclusive capital cost of the construction of a tramway from Queen Square, along Worcester Street and Lea Road to the borough boundary, would be approximately as follows:

Permanent way	£10,400
Electrical equipment	3,320
Main feeder cables	1,935
Rolling stock, 3 double-deck cars	1,800
	£17,455

The total capital expenditure involved in initiating a motor omnibus service to give the same car-mileage would be appoximately as follows:

Three double-deck motor omnibuses to carry 36 passengers at £950	£2,850
Allow for petrol storage tanks, etc., at car depôt ..	200
	£3,050

Cost of Operation and Maintenance of Tramway Service.

Assuming a 15 minutes service from 7 a.m. to 11 p.m., augmented to 10 minutes for two hours at noon and three hours in the evening, the total annual car-mileage would be 74,000, and the cost of operation of a tramway system would be approximately as follows:

	d.	Cost per Car-mile.
Operating Costs—		
Electricity	2·24	
Wages: Motormen, conductors, etc.	1·91	
,, Oilers and cleaners	·168	
Oil, grease, and sundry stores	·06	
Track watering and cleaning	·05	
Sand and salt	·015	
Tickets, coal, light, and miscellaneous items common to electric car and 'bus	·276	
		4·72
Maintenance and Renewals—		
Permanent way	·1	
Feeders and conduits	·05	
Rolling stock	·4	
		·55
Maintenance of Lorain equipment		·25
General Charges—		
Rent, rates, insurance, and miscellaneous		·3
Total working costs		5·82
Capital Charges (Capital expenditure, spread over 40 years)—		
5% Interest and sinking fund on capital expended, £17,455 = £872 15s.	2·83	
Depreciation and renewals	1·7	
		4·53
Total cost		10·35

Cost of Operation and Maintenance of Motor 'Bus Service.

Assuming the same car-mileage, 74,000, it is estimated that the cost of operation of a motor omnibus service would be approximately as follows:

	d.	Cost per 'Bus-mile.
Operating Charges—		
Petrol	1·5	
Wages of drivers, conductors, etc.	2·5	
,, oilers and cleaners	·2	
Tickets, coal, light, miscellaneous (items common to electric car and 'bus)	·276	
		4·676
Maintenance and Renewals—		
Tyre renewals	2·0	
Rolling stock (10% on capital cost) 10% on £2,850 = £285	·025	
		2·925
General Costs—		
Rents, rates, insurance, and miscellaneous		·3
		7·901
Capital Charges* (Capital expenditure spread over 5 years)—		
Interest and depreciation, 25% on £2,850 = £712 10s.		2·3
Total cost		10·201

* It will be observed that in the case of tramways the repayment of the capital expenditure is spread over a period of 40 years, whilst the capital expenditure for motor omnibuses is spread over five years.

Type of 'Bus.

Your Committee have instructed the engineer to prepare specifications and obtain tenders for three double-deck petrol omnibuses. Each 'bus will be provided with a 30 B.H.P. petrol engine, and will be capable of a maximum speed of 14 miles per hour. The approximate dimensions are as follows:

	ft.	in.
Length of body	12	5
Length of rear platform	2	10
Width over roof	6	3
Width over side pillars	5	9
Height inside (floor to roof)	6	1
Wheel base	11	0
Wheel gauge	6	0

Seating Capacity.

	16	passengers inside.
	18	,, on roof.
	2	,, beside driver.
Total ..	36	passengers.

Your Committee have very carefully considered this matter, and are of opinion, having regard to all the circumstances, that the provision of a motor omnibus service will meet the requirements of the Lea Road and Penn Fields district.

As the matter is somewhat urgent, and as from three to four months will be required before delivery of the vehicles can be made, your Committee are desirous to have authority to accept such tender, not exceeding the amount hereafter mentioned, as they deem desirable.

Your Committee therefore recommend that the Committee be authorised to invite tenders for three motor omnibuses.

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LONDON COUNTY COUNCIL TRAMWAY MATTERS.

The London County Council held its usual weekly meeting on Tuesday, February 7, when the recommendation of the Works Committee that a contract be made with Dorman, Long and Company, Limited, for the supply and fixing of iron and steel work in connection with the erection of the Streatham car sheds, was adopted.

On the reception of the report of the Highways Committee the chairman, Mr. J. Allen Baker, replying to various questions said that it was the duty of the Housing Committee to take action with regard to the discontinuance of working men's trains. At present the Council would not increase its tramway service. If any purchase proposal came from the London Southern Tramways Company it would be considered. The suggestion that independent motor-driven tramway cars should be used on the present horse lines had been considered, but the Committee were assured that it was impossible to put a heavy tramcar run by motors on the present rails. The Committee were considering the question of very early morning cars. The Battersea lines would be among the first to be electrified, and it was hoped to have the whole completed by the time the Greenwich generating station was finished.

Conditions of Labour of Employees.

At the meeting of the Council on Febuary 14, the Highways Committee presented a long report on the subject of the conditions of labour of the tramways staff. They stated that they had recently had before them certain further matters bearing on the subject. The most important point was that relating to the duration of the working shifts, and on this matter they had considered a petition by the Amalgamated Society of Tramway and Vehicle Workers, and they had received a deputation representing the men and the society. The requests made by the men, as compared with the existing conditions, were as follows:

(1) The rate of pay for drivers and conductors to be 5s. per day for the first six months, 5s. 6d. for the second, and 6s. 3d. after twelve months' service. This compared with 4s. 9d., 5s. 3d., and 5s. 9d. at present.
(2) All service to be taken by seniority. This was the present regulation, with the addition of the words "as far as possible."
(3) Spare men to be paid 2s. per day in the event of their showing up for and not obtaining work.
(4) Hours of labour to be nine per day, or 54 per week, each day's work to be completed within twelve consecutive hours. At present the average was 9⅞ hours per day, or 56¼ per week, with relief varying from 40 minutes to 7 hours 50 minutes.
(5) Drivers and conductors, after two years' service, to receive one week's holiday per year with pay. The present arrangement was one day in every seven.
(6) All drivers and conductors called upon to work on their stand-off day to be paid at the rate of time and a half. At present they were paid at the ordinary rate.
(7) The formation of a board of conciliation, consisting of representatives of the men and of the Highways Committee.

The Committee presented a table (which is reproduced on the following page) giving a comparison between the duties in January, 1900, and those in November, 1904. From this it appeared that the spread-over in January, 1900, averaged 14 hours 1 minute, consisting of 3 hours 5 minutes of relief, and 10 hours 56 minutes of actual work. In November, 1904, the average spread-over was 12 hours 28 minutes, consisting of 3 hours 9 minutes of relief, and 9 hours 19 minutes of actual work. Regarding spare men, an effort had been made to reduce the uncertainty of this class of labour, with the result that those men now received more work than had ever been the case before. With reference to the men working under circumstances of special emergency during their own time, the Committee thought it would be reasonable to pay for all time so worked at the rate of time and a quarter. The cost of the reduction that had been made in the length of spread-over time had been at the rate of £1,500 per annum. The estimated cost of giving increased remuneration to spare men, and at the rate of time and a quarter men working during their stand-off time was £1,390 and £110 respectively. The total annual cost thus involved under all these heads was £3,000.

Other tables show the number of drivers and conductors, their rates of pay, and the increase in the number of the Council's operating staff, as compared with that employed by the London Tramways Company before its undertaking was purchased by the Council. Out of a total of 1,620 drivers and conductors now employed, 1,125 got 6s. 3d. per day, 92 got 5s. 9d., 272 got 5s. 3d., and 131 got 4s. 9d.

The Committee contended that the imminence of electrification in other parts of London made it essential that the utmost care should be taken in making any alterations in the present standard, seeing that the staff conditions on some lines to be electrified were inferior to those set up by the Council. Another important factor was the very heavy capital charges now accruing. The conditions at present obtaining on the Council's tramways were certainly on a level with the best in force on any other tramway in the country. The Committee did not feel justified in recommending any alteration which would circumscribe the Council's freedom in the future in improving the tramway service consistently with placing that service on a sound financial basis. They accordingly recommended that the following alterations be made, as from April 1 next, in the conditions of labour:

(1) That employees on the spare list, when summoned to attend at any of the tramway depôts in case their services should be required, should be paid at the rate of 6d. an hour for actual work performed, with a minimum of 1s. whether they obtained it or not.
(2) When tramway employees are required to work during their stand-off time they shall be paid at the rate of time and a quarter.

They also proposed that the employees in the Amalgamated Society be informed that the Council was unable to accede to their requests except so far as they were covered by the above alterations.

Holborn to Strand Improvement.

A joint report by the Highways and Improvements Committees recommended that the drawings, specifications, and estimate (£44,000), for the paving and other works, including the construction of the portion of the tramway subway for the section of Kingsway between Great Queen Street and the premises of the Metropolitan Electric Supply Company in Sardinia Street, be approved and referred to the Works Committee, with a view to the work being undertaken by them.

On the reception of the Highways Committee's report, Mr. Allen Baker said that the cost of granting the men's demands would involve £31,000 a year, and could not therefore be entertained. He admitted that the one day's rest in seven was given without pay; but thought that the employees had been treated with great generosity.

The recommendations were unanimously adopted.

At the Council meeting on February 21, the Highways Committee submitted a report on the revision of salaries of the tramway permanent staff. As the result of consideration of reports by the chief officer of tramways and the clerk of the Council, the Committee presented recommendations for the increase of salaries of 20 officials, involving additional expenditure in the first year of £316 10s., and thereafter of £341 10s. a year. In the majority of cases the increase was recommended on the general ground of added duties and responsibility due to the very heavy additional work resulting from the use of electric traction, the effects of which could not be adequately judged when the Committee last reported on the matter. The proposed alterations would take effect as from April 1 next. The Committee recommended that the undermentioned increases be made:

Mr. J. Welling, permanent way engineer, from £450 to £475 on April 1, 1905, and to £500 a year on April 1, 1906.
Mr. H. Vorley, accountant, from £350 to £400 a year.
Mr. H. Holland, paymaster, from £250 to £280.
Mr. C. R. Johnson, assistant traffic manager, from £235 to £250.
Mr. J. Glover, superintendent of claims, from £225 to £250.
Miss E. Hodge, superintendent of women checkers, from £200 to £215.
Mr. G. Dickens, superintendent of stores, from £200 to £220.
Mr. H. Sellar, general clerical assistant, from £185 to £200.
Mr. J. Terry, traffic superintendent, from £170 to £185.
Mr. J. Brown, traffic clerk, from £135 to £145.
Mr. R. J. Bean, assistant paymaster, from £130 to £140.
Mr. G. Bartle, collector and inquiry officer, from £130 to £140.
Mr. E. Lowe, collector and inquiry officer, from £117 to £125.
Mr. R. E. Meatyard, principal bookkeeper, from £110 to £120.
Messrs. T. H. Bell, W. Woolridge, H. Hider, and M. A. George, clerks in the general office with special duties, each from £80 to £90.
Messrs. C. H. Woodman and T. R. Ireland, general clerks, from £71 10s. and £65 to £80 and £75 respectively.

Acquisition of Property, etc.

In reference to the additional property required for the extension of the generating station site at Greenwich and for providing egress and ingress at Clapham car shed, the Committee reported that the cost at Greenwich would be about £25,557, and that at Clapham about £1,337, making a total of £26,894. This showed a saving of about £4,106 on the estimate approved by the Council on July 29, 1902.

The Committee recommended that incandescent electric lamps instead of arc lamps should be used in the car sheds at New Cross and Camberwell. This would enable lights to be placed in the car pits, where no lights had been yet provided for. The work would be carried out by Messrs. Marshall and Company, as a variation of their existing contract for the wiring and fitting for electric lighting. There would be an additional expenditure of £550 over the existing contract price of £2,203.

On the introduction of electric traction it had been found, the Committee remarked, that the tramway depôt at Queen's Road, Peckham, would no longer be required. The depôt consisted of 30 railway arches, and provided stabling for 64 horses. It was held on lease from the Brighton and South Coast Railway Company at a rent of £1,250 per annum, with a covenant to keep the premises in repair. The tenancy was determined on September 29, 1904, but the railway company subsequently claimed £3,042 in respect of dilapidations. After negotiations, the company agreed to accept £1,000 in settlement, and the Committee had arranged for the settlement of the claim accordingly.

All the recommendations were adopted.

Motor Omnibuses and Tramways.

Mr. J. Allen Baker (the Chairman of the Highways Committee) in replying to questions in regard to motor omnibuses, said that according to a published statement the working cost of a motor 'bus including repairs was from 11½d. to 1s. per car-mile, and its carrying capacity 34; the working cost of an electric tramcar was from 5d. to 6d. per

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TABLE SHOWING RATES OF PAY AND HOURS OF LABOUR WHICH PREVAILED WITH THE VARIOUS COMPANIES AS COMPARED WITH RATES OF PAY AND HOURS OF LABOUR NOW IN FORCE ON THE LONDON COUNTY COUNCIL TRAMWAYS.

Designation.	LONDON TRAMWAYS. Acquired January, 1899.			South-East Metropolitan. Acquired April, 1902.			South London Tramways. Acquired November, 1902.			London, Deptford and Greenwich. Acquired July, 1904.			LONDON COUNTY COUNCIL.		
	Rate of pay per week.	Number of days per week.	Hours of labour per week.	Rate of pay per week	Number of days per week.	Hours of labour per week.	Rate of pay per week.	Number of days per week.	Hours of labour per week.	Rate of pay per week.	Number of days per week.	Hours of labour per week	Rate of pay per week.	Number of days per week.	Hours of labour per week.
Drivers	31s. 6d. to 42s.	7	80	33s. 3d. to 42s.	7	77	} 26s. 3d. to 31s. 6d. {	7	70	33s. 3d. to 40s. 3d.	7	77	**28s. 6d. to 37s. 6d.**	**6**	**60**
Conductors ...	31s. 6d. to 42s.	7	80	33s. 3d. to 38s. 6d.	7	77		7	70	33s. 3d. to 36s. 9d.	7	77	**28s. 6d. to 37s. 6d.**	**6**	**60**
Stablemen ...	23s. to 30s.	7	77	—	—	—	25s. 4d. to 28s.	7	77	27s.	7	70	**26s.**	**6**	**60**
Washers ...	22s. to 28s.	7	77	29s. 2d.	7	70	33s. 3d.	7	70	27s. to 32s. 6d.	7	70	**25s. to 30s.**	**6**	**60**
Farriers	33s. to 36s.	6	56½	—	—	—	36s. to 42s.	6	57	—	—	—	**39s. to 43s. 6d.**	**6**	**54**
Track Cleaners..	21s. to 24s. 6d.	7	77	—	—	—	21s.	7	70	—	—	—	**25s.**	**6**	**60**
Pointsmen ...	15s. to 20s.	7	77	—	—	—	—	—	—	—	—	—	**24s.**	**6**	**60**
Trace boys ...	15s. to 18s.	7	77	13s.	7	60	16s.	7	70	—	—	—	**14s. to 18s.**	**6**	**60**
Ticket Inspectors	40s. to 42s.	7	80	32s. to 35s. 10d.	7	77	37s. 6d.	7	81	36s. 9d. to 40s. 3d.	7	91	**42s.**	**6**	**60**
Regulators ...	42s.	7	80	—	—	—	35s.	7	81	38s. 6d.	7	91	**42s.**	**6**	**60**
Night Inspectors	32s. to 42s.	7	74	—	—	—	40s. 3d.	7	81	40s. 3d.	7	91	**42s.**	**6**	**60**
Foremen ...	36s. to 55s.	7	80	Foreman washer, 35s.	7	70	Foremen 45s. to 65s.	7	84	42s.	7	84	**42s. to 64s. 6d.**	**7**	**70**
Deputy Foremen	40s.	7	80	—	—	—	37s. 6d.	7	84	—	—	—	**42s.**	**7**	**70**

STATEMENT OF RATES OF PAY AND HOURS OF LABOUR OF MOTORMEN AND CONDUCTORS COMPARED WITH THE CONDITIONS OF OTHER CORPORATIONS.

Corporation.	Rate of pay—Motormen.		Rate of pay—Conductors.		Hours of labour.		Average number of hours worked per day.	Average period over which the day's work is spread, including reliefs.	Longest period over which the day's work is spread, including reliefs.	Shortest period over which the day's work is spread, including reliefs.	Average length of relief.
	Per hour.	Per day.	Per hour.	Per day.	Per week.	No. of days per week.					
Bradford	5½d. to 7d.	4s. 7d. to 5s. 10d.	4½d. to 6d.	3s. 9d. to 5s.	60	6	—	—	—	—	—
Glasgow	5·33d. to 6·66d.	4s. to 5s.	5·33d. to 6·66d.	4s. to 5s.	54	6	9 hours.	11 hrs. 40 mins.	16 hrs. 42 mins. An exceptional case, very few "spreads" exceed 14 hours. 80 per cent. under 12 hours.	9 hrs. 12 mins.	2 hrs. 40 mins.
London County Council	**5·70d. to 7·50d.**	**4s. 9d. to 6s. 3d.**	**5·70d. to 7·50d.**	**4s. 9d. to 6s. 3d.**	**56**	**6**	9 hrs. 19 mins.	12 hrs. 28 mins.	Under 16 hours.	9 hrs. 30 mins.	3 hrs. 9 mins.
Liverpool	6d. to 6½d.	5s. to 5s. 5d.	5d. to 6d.	4s. 2d. to 5s.	60	6	10 hours.	12 hrs. 47 mins.	14 hours.	10 hrs. 30 mins.	About 2½ hrs.
Leeds	6d. to 6½d.	5s. to 5s. 5d.	5d. to 6d.	4s. 2d. to 5s.	60	6	10 hrs. 2 mins. This includes reporting and going off time, etc.	10 hrs. 54 mins.	15 hrs. 59 mins.	8 hrs. 18 mins.	1 hr. 2 mins.
Manchester	5¾d. to 7d.	4s. 4d. to 5s. 3d.	5½d. to 6¾d.	4s. 1½d. to 5s. 0¾d.	54	6	*Regular cars run out in morning latter come on 4 hours.	about 18 hours and get relieved again about 5 12 hours.	of 2 shifts of 9 a journey for o'clock and work Week days 14 hrs. Saturdays 16 hrs.	hours each. First dinner by a second night out without 10 hours.	set of men take car set of men, which out further relief. 3 hours.
Newcastle	5·77d. to 6·66d.	4s. 4d. to 5s	5·77d. to 6·66d.	4s. 4d. to 5s.	54	6					
Nottingham	5½d. to 6½d.	4s. 7d. to 5s. 5d.	5d. to 6d.	4s. 2d. to 5s.	60	6	—	—	—	—	—
Portsmouth	5d. to 6d.	4s. 2d. to 5s.	4·40d. to 5d.	3s. 8d. to 4s. 2d.	60	6	—	—	—	—	—
Sheffield	6d. to 6¾d.	5s. to 5s. 7½d.	4½d. to 5d.	3s. 9d. to 4s. 8d.	67	6½	{ — 10 hours.	10¼ hours. 15 hours.	11 hours. 16¼ hours.	9 hours. 14 hours.	45 mins. —

* In addition there are in Manchester what are known as part-day services. These commence running for the workmen's services at about 4 o'clock a.m., and the operating staff remain on duty till 9·30 or 10 a.m. These cars commence running again with the same men in the evening for the rush hours at 5 o'clock p.m., and continue until 7 or 8 p.m. This gives for these services a maximum spread over about 16 hours. The men on these services are paid for time actually worked.

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car-mile, and carrying capacity from 50 to 70, there being a much greater margin between the working expenses and earning power, which was far more than sufficient to cover the disbursements upon tramways for capital charges, paving, maintenance, etc. The correctness of this statement was borne out by the fact that many electric tramways live and pay dividends on a lower earning per car-mile than the sheer working expenses of the motor 'bus, and that while a large part of the motor traffic expense was defrayed by the ratepayers in the shape of road construction and repairs, the tramway paid for maintenance of its own track, paving the surface between the rails and 18 in. outside of them, and also paid rates upon its track. The tramway was thus a ratepayer, even when it belonged to the local authority; and so the 'bus service was rate supported and not the tramway. They therefore need not fear any serious opposition to the tramways from motor omnibuses. With regard to the suggestion that independent motor tramcars should be run in place of horse-cars, the Committee knew positively that the present horse lines were so light that it would be impossible to run motor tramcars on them without entire reconstruction. The vice-chairman, the chief officer, and himself had been to the recent motor exhibition, but could not find any motor applicable to a tramcar. They were keeping an open mind. In reply to Mr. Collins, Mr Baker said it was impossible to give details of the weekly expenditure on the tramways, or, in other words issue a weekly balance-sheet. The annual report would shortly be published.

Temporary Tramway Traffic.

At the meeting of the London County Council on February 28, the Highways Committee referred to the general practice of the Council when reconstructing the tramways for electrical traction, to maintain the service of horse cars on the routes during the continuance of the work in order that the traffic might be disturbed as little as possible. The following is, shortly, the method which has been adopted: In the reconstruction of a double line of tramways the operations are carried on in sections on only one track at a time, the side of the road affected being closed for traffic. The cars are then run in one direction on the remaining track, and in the other direction on a temporary track laid on the surface of the road, between the permanent track and the footway. When the track under reconstruction can be reopened for traffic, the second track is closed, and the operation is reversed. The results of using this method of continuing the tramway services are regarded as satisfactory as far as regards public convenience, and a similar arrangement has been generally used elsewhere when tramways have been under reconstruction.

The Committee's attention had been drawn to a case in the High Court in which the Council's authority to place raised temporary tramway tracks on the surface of the road had been questioned. This was an action brought by Thomas Tilling, Limited, omnibus proprietors, against Dick Kerr and Company, Limited, the Council's contractors for the reconstruction of a portion of the Greenwich section of the Council's tramways, in respect of damage alleged to have been caused to the plaintiffs' omnibuses in a number of accidents, due to the vehicles having to pass over the temporary tracks laid by the contractors on the route of the tramways in pursuance of the terms of their contract with the Council. In this case, Mr. Justice Warrington, in the King's Bench Division, gave judgment on the 18th ult, in favour of the plaintiffs, on the ground that the clause in the London County Tramways (Electrical Power) Act, 1900, which states they may "reconstruct or make such alterations to the tramways" did not point to any temporary expedient for carrying on the traffic, but to the permanent alterations that were to be made. In the opinion of the judge, the works constructed by the Council were not necessary for adapting tramways to be worked by electricity, but were necessary, if at all, for maintaining the tramcar service uninterrupted. Works for this purpose were not covered by the Act and the defendants accordingly were not protected by it. A stay of execution was granted by the judge in order that the defendants might appeal, if they desired, against the decision. The Committee, however, were unable to say whether the appeal would be proceeded with. They considered the matter of such importance that they thought the Council would be wise to seek the necessary powers in the Council's Tramways Bill now before Parliament. They recommended therefore that the Parliamentary Committee be instructed to take steps in the present session of Parliament to seek statutory authority for the Council, in connection with the reconstruction of its tramways, to lay down raised temporary tramway tracks, and to maintain car services thereon during reconstruction.

Purchase of Motor Vehicles.

The Committee reminded the Council that in November last they approved an estimate of £1,000 for the purchase of a motor breakdown van and a motor car for the use of the Tramway Department. They reported that as the result of very careful consideration they ordered an "Arrol-Johnston" breakdown lorry and a 12 H.P. "Wolseley" landaulette. The cost of the two vehicles would be about £888, and having regard to the enquiries that they had made as to the efficiency of those vehicles for the purposes for which they were required, they thought that the arrangements made might be regarded as very satisfactory.

The report was adopted.

WATERLOO AND CITY RAILWAY
(WORKING RESULTS).*

By Herbert Jones.

1.—Introductory Remarks.

Shortly after the opening of the Waterloo and City Railway, in August, 1898, papers were read before the Institution of Civil Engineers dealing with the construction, equipment, and signalling of the line. Nevertheless, a short description of the plant is necessary in order that the conditions under which the working results are obtained may be fully understood. The Waterloo and City Railway Company was incorporated by Act of Parliament in 1893. The construction of the line was commenced in June, 1894, and the railway was opened for traffic on August 8, 1898. The line is worked by the London and South Western Railway Company under an agreement dated March, 1894.

2.—Description of Line.

(*a*) *Stations.*—There are only two stations, at Waterloo and the City. The former is placed within four of the arches of the viaduct upon which the London and South Western Company's terminus is built, and is approached by inclines and stairways. The latter is connected by an incline to the street subways at the Bank of England, and to the station of the Central London Railway. At Waterloo the rails are 41 ft. below those of the South Western Railway, and at the City 59 ft. below the surface of Queen Victoria Street. The total length of the line is 1 mile 46 chains.

(*b*) *Tunnels.*—The line is double throughout, in separate tunnels. The cast iron lining of the tunnels consists of a series of rings each 20 in. long. A ring is made up of seven segments and a key piece at the top. The minimum internal diameter of the tunnels is approximately 12 ft. From Figs. 4 and 5 it will be seen that the gradients and curves on the line are exceptionally severe, there being four curves of five chain radius on each of the running roads, and an incline of 1 in 60 over half a mile in length.

(*c*) *Sidings.*—Open air sidings, pits, and a carriage shed, are provided at Waterloo, where the rail level is only 16 ft. below the street level. Rolling stock and heavy materials are brought on to the line by means of a 30-ton hydraulic lift, which communicates between one of the South Western railway sidings and a siding off the Waterloo and City up line. Siding accommodation for two trains is also provided at the City station

3.—Description of Generating Station.

The generating station, repair shops, and offices are at the Waterloo end of the line, and are now undergoing considerable alteration owing to a portion of the space occupied being required for the enlargement of the London and South Western terminus.

(*d*) *Boiler House.*—The coal is brought to Waterloo by the London and South Western Railway, and lowered two trucks at a time to a siding off the Waterloo and City up tunnel by the 30-ton lift already referred to. Thence the trucks are shunted through the up platform into the general sidings. From the siding nearest the generating station the trucks are lifted by means of a 20-ton hydraulic lift to a coal siding at the ground level, running parallel to the boiler house. Below this siding is a bunker of 200 tons capacity. Opposite each boiler a small door is provided in the bunker front, through which the coal gravitates on to the boiler house floor. The boilers, which was originally fitted with mechanical stoking gear, are now hand fired with the best Welsh steam coal. The ashes are raised from the boiler house floor and delivered direct into trucks by a continuous-bucket elevator. A feed-water tank of 19,000 gallons capacity is situated over the coal bunker; this tank is supplied from the condensed water filters, and with make-up water from the street mains. A Babcock and Wilcox heater, situated between the tank and the pumps, utilises the exhaust of the few auxilary steam engines to raise the temperature of the feed-water to about 100 deg. F. before it enters the economisers. The total water pumped into the boilers is measured by a Kennedy water-meter in the main between the tank and the feed-pumps. Two three-throw pumps, motor-driven through worm-gearing, and one Worthington steam pump, are provided for boiler-feed purposes. The feed-pipes are in duplicate throughout. The boiler house contains five Economic boilers 14 ft. long and 8 ft. diameter, with two flues each 2 ft. 8 in. diameter, and ninety-two tubes of 3 in. internal diameter. Each boiler has a grate area of 30·5 sq. ft., and a heating surface of 1,112 sq. ft. The working steam-pressure is 160 lb. per sq. in. The rated evaporation of each boiler is 7,000 lb. per hour. The boilers are fitted with Hotchkiss cleaners, which have improved the circulation and reduced the cost of cleaning. The chimney has an area of 43 sq. ft., and is 140 ft. high. It is in the middle of the boiler house, with three boilers and a Green's ecomomiser with 256 tubes on one side, and two boilers and an economiser with 224 tubes on the other. Duplicate steam-mains are provided and each boiler and engine can be opened

* Paper read before the Tramways and Light Railways Association at the Society of Arts Hall, Adelphi, London, on February 23, 1905.

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out to either main. Only one main is kept heated up, except when mains are changed over.

(*e*) *Engine Room.*—In the engine room are six high-speed self-lubricating Belliss engines, direct-coupled to Siemens bipolar dynamos. The engines are vertical, three-crank, tandem-compound, and can develop 360 I.H.P. when running at 380 revolutions per minute, with a steam pressure of 160 lb. per sq. in. and a vacuum of 25 in. The diameter of each of the three high-pressure cylinders, is 8 in., and of the low pressure 14 in. with a stroke of 9 in. The engines are fitted with the usual throttle valve type of governor, and a flywheel, weighing 6 tons, is carried on the engine-shaft between the engine and the dynamo. The governing is excellent, between the usual working limits of quarter load and full load the variation in speed does not exceed 2 per cent. It will be seen from Fig. 2 that the variation of voltage is only 4 per cent., although the amperes vary from 130 to 895, and are never steady for many seconds together.

The 200 KW. dynamos are compound-wound with the series-winding adjustable between 6 and 32 turns, in steps of 4 turns. Such a wide range of adjustment is, however, found unnecessary. The average of tests, on different sets, taken at the works of Messrs. Belliss and Morcom, gave a combined mechanical and electrical efficiency of over 87 per cent. at full load, and a steam consumption of 27 lb. per KW. hour at full load, and 30 lb. at half load, running condensing.

(*f*) *Switchboards.*—The main switchboard is on a raised platform along one side of the engine room. It consists of six dynamo panels, one voltmeter and feeder panel, and two panels with switch-gear for control of five motor-driven pumps at different parts of the line. Each dynamo circuit is provided with a Siemens-Halske watt-hour meter, Kelvin ammeter, main fuse, main switch and overload cut-out in the positive, and a combined negative and equalising switch. In each feeder there is an ammeter and overload cut-out; the latter is mechanically interlocked with a hand-switch which is connected in series with it. The locking does not allow the hand-switch to be either closed or opened before the cut-out, so that the circuit is always completed by the switch but broken by the cut-out. In the event of closing on to a short circuit the cut-out opens immediately the hand-switch is closed. The lighting of the stations and tunnels is controlled from a separate switchboard. It was realised how important it is to keep the lamps in under all circumstances, and on this account separate lighting circuits are provided starting as near as possible to the source of supply. The method of connecting up these circuits to the dynamos has been altered more than once in order to provide against the extinction of lights in case of the failure of a generator-armature. The following arrangement has proved most satisfactory. Two special lighting bus-bars are fixed at the back of the main switchboard, to which the positive terminal of each dynamo can be connected through a switch and fuse. These two bus-bars are never during traffic hours supplied from the same dynamo. The two lighting bus-bars on the main board are connected to two bus-bars on the lighting board through Thomson-Houston wattmeters. Each lighting feeder can be switched to either of these bns-bars by means of a throw-over switch. The lights at each station are divided and connected to two separate mains, which are normally switched on to either bus-bars, and so are supplied by different dynamos. Gas is also provided throughout the stations, and is kept alight on the by-pass, so that a whole station can be turned full on from a cock in the main. The tunnels are provided with 16-candle-power lamps, spaced 60 ft. apart and wired five in series. The motors driving the feed pumps, condenser pumps, air compressor, and machine tools, are connected up to the lighting switchboard.

4.—Description of Distribution System.

(*g*) *Feeders.*—Two main feeders, each of 1 sq. in. sectional area, are run from the automatic circuit-breakers on the main switchboard to link boxes at Waterloo Station. Each feeder consists of two cables connected in parallel, and the links are so arranged that any cable can be entirely disconnected without interfering with the working of the line. From Waterloo to the City a cable of 0·5 sq. in. sectional area, insulated with jute and lead-covered, is run through each tunnel. Each of these cables is divided into nine lengths of about 800 ft., connected up by link boxes. The conductor rail in each tunnel is also divided up into nine sections, with a sectional insulator opposite every link box. The cable and conductor-rail are connected on each side of every sectional insulator through a link, and are therefore in parallel with a cross connection every 800 ft. By this arrangement the best use is made of both the feeder and the conductor-rail for supplying energy to the moving train. The feeder and conductor-rail in parallel have a conductivity equal to that of about 1·1 sq. in. of copper.

(*h*) *Conductor Rail.*—The conductor rail is a steel channel 4 in. by 2 in., and $\frac{13}{16}$ in. thick. It has a cross section of 4·5 sq. in., and weighs 46 lb. per yard. It is laid in 30 ft. lengths, joined together with copper fishplates placed inside the inverted channels, and riveted up with four $\frac{3}{4}$ in. rivets countersunk flush with the top of the channel. The conductor rail is supported on porcelain insulators with oil lips; the use of oil is, however, found quite unnecessary. At the ends of each section, and at crossings, anchor insulators are provided to which the conductor rail is bolted. The conductor rail is central between the running rails, and at the same level. At crossings the conductor rail is raised one inch, and the ends are bent parallel to the switch rail, so that the contact shoe passes over the gap without touching the running rail. The resistance of the conductor rail with bonds and short cables connecting the sections to the link boxes is 0·09 ohm per mile. The insulation resistance of the conductor rail, as shown by the leakage test, is usually about 10,000 ohms per mile.

(*i*) *Rail Return.*—The running rails are bull-headed, and weigh 87 lb. per yard. They are carried in cast iron chairs on longitudinal sleepers in the iron tunnels, and on cross sleepers in the stations and sidings. Originally the rail joints were bonded with 2 in. by $\frac{1}{8}$ in. copper bars, which bridged across the fishplate and two chairs placed one at each end of the fishplate. The bonds were riveted to the web of the rail by three $\frac{3}{8}$ in. rivets at each end. This type of bond is much too rigid, and after being in use about two years breakages became frequent. Trials were made with several types of bonds, and as a result the author decided to renew the solid bonds when broken with three flexible bonds each of 37 strands ·0756 in. in diameter. The terminals, which are fused on to the strands and afterwards forged, are riveted into the old holes in the web of the rail by a hydraulic riveter carried on a bogie, and worked by a hand pump. The rivets are closed under a pressure of about 40 tons. None of the solid bonds were found broken until the

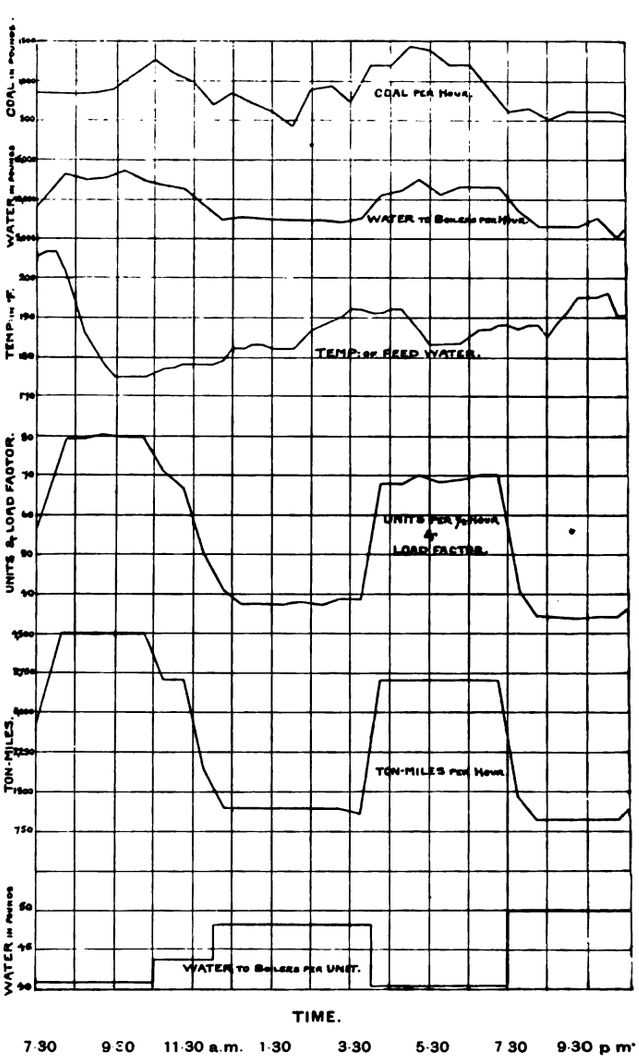

Fig. 1.—Record over Running Hours; 24 Hours' Test. March 16, 1904.

third year of working, when there were 55; in the fourth year there were 85, in the fifth 196, and in the sixth 162. The total number of rail joints is about 1,100. The broken bonds have usually been in the outer rail of curves, but they are now being found at other parts of the line where the speed of running is high. Measured on a potentiometer the resistance of a joint bonded with flexible bonds is about 0·00005, as compared with 0·00004 ohm for an equal length (4 ft.) of continuous rail; so that the bonded rails in 30 ft. lengths have a resistance only about $3\frac{1}{3}$ per cent. higher than that of a continuous rail. Rail renewals are now being made with 90 lb. rails in 45 ft. lengths, making a slight reduction in the resistance of the return circuit, and a considerable

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reduction in the cost of bonding. The two running rails are cross-bonded every 100 ft., and in addition the rails in the "up" and "down" tunnels are connected at each of the 10 cross passages. A supplementary return, consisting of a bare copper conductor of 1 sq. in. section is laid in each tunnel for a distance of 3,300 ft. from the Waterloo end of the line. The two conductors are cross-bonded to the rails every 100 ft. by a connection of 0·125 sq. in. in area. The four running rails and two supplementary cables are connected to a common negative terminal board at Waterloo Station. This board is connected to the negative bus-bar on the main switchboard by two cables, each of 0·75 sq. in. section. The resistance of the return circuit between the far end of the line and the negative bus-bar on the main switchboard is approximately 0·016 ohm. The drop of voltage in the return is always well within the Board of Trade limit of seven volts.

5.—Traffic Requirements.

The line is used chiefly as a feeder to the City, hence the bulk of the passengers are carried between 8 a.m. and 11 a.m. on the up line, and between 4 p.m. and 7 p.m. on the down line, as shown clearly on Fig. 6. During the morning load a 4-minute service of trains is run with trains consisting of four cars and seating 204 passengers. It will be readily understood that the number of passengers travelling mid-day

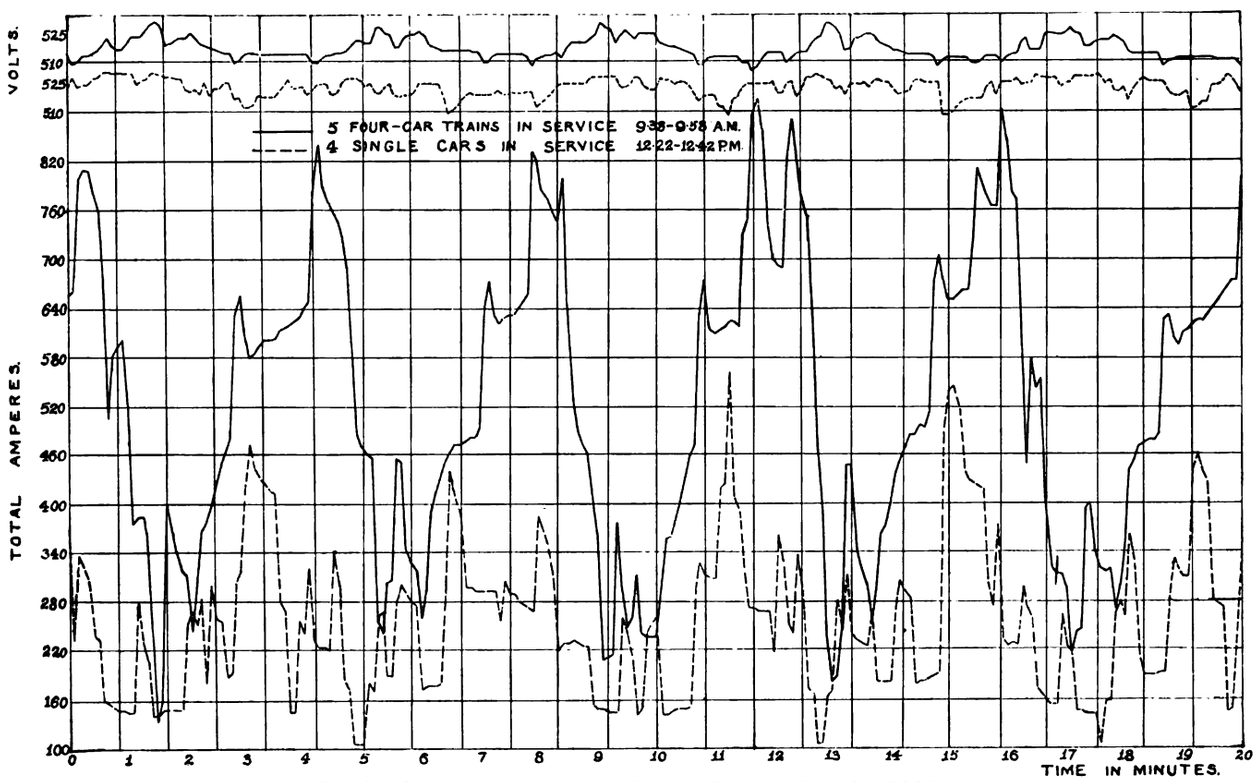

Fig. 2.—Output Curves of 4 Minutes' Service, May 10, 1904.

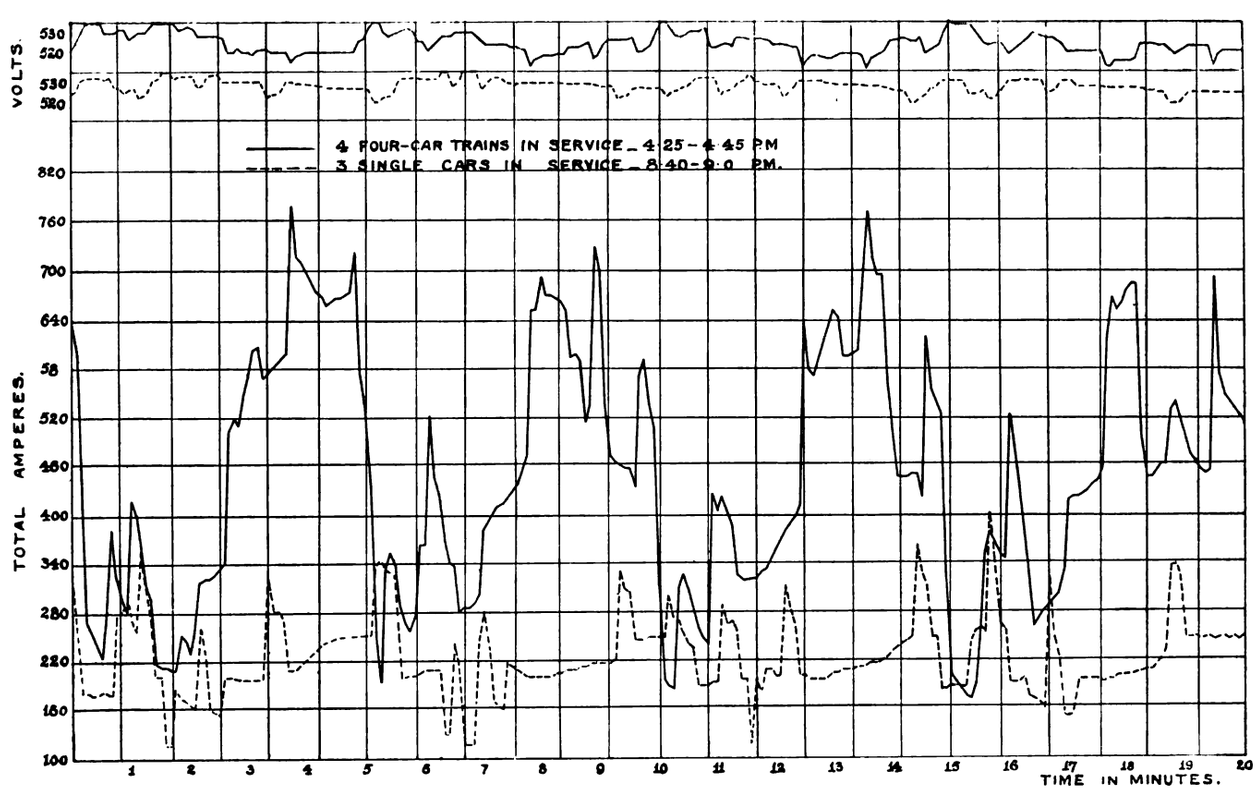

Fig. 3.—Output Curves; 5 Minutes' Service, May 10, 1904.

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will not justify a continuation of the service, and on the other hand if the interval between trains is increased to more than five minutes many passengers will travel some slower way rather than wait for a train. The rolling stock provided at the opening of the line consisted of five 4-car trains, which were run on a 6-minute service during hours of heavy traffic and a 10-minute service mid-day and after 7 p.m. It was soon realised, however, that the public expect something better than a 10-minute service on electric underground railways in London, and at the recommendation of Mr. Douglas T. Heap, the company placed an order for five single cars for use at hours of light traffic. The cars have now been in service over four years with highly satisfactory results. A 4-minute service is now maintained from 7-30 a.m. to 3-30 p.m., and a five-minute service for the remainder of the day. It may be of interest to compare the output curves, Fig. 2; the full lines give the total output of the generating station while the 4-car trains are running, and the dotted lines while the same service is being maintained with the single cars. The ton mileage per hour is 4,500 in the former case, and 1,170 in the latter.

6.—Rolling Stock.

Four-Car Trains.—Each of the six 4-car trains, now provided, is made up of two motor-cars and two intermediate cars, known as "trailers" Each car is carried on two four-wheeled bogies, the first and last bogie of the train carrying a motor on each axle. The portion of each motor-car over the motors is formed into a compartment for the motorman, and is fitted with a maximum cut-out controller for 4-motor equipment, "Weston" ammeter, Westinghouse brake valves and gauges, and hand-brake wheel. The motors are iron-clad and of a nominal output of 60 B.H.P. each. The armature is built direct upon the axle, and the magnets are carried by two bearings, one each end of the armature, the thrust of the magnets being taken upon the bosses of the wheels. The armatures have slotted cores wound with a two-turn drum winding, and have 109 bars in the commutator. The field-magnets are of cast steel with four poles, on two of which are placed formers carrying the series winding. The four motors on each train are controlled direct from the leading motor-car, the controller at the rear of the train being locked in the "off" position. In order to give complete control of the two motors at the rear of the train eight leads are run from end to end. The cables are run on the roofs of the cars in "Uralite" fireproof troughing enclosed in a sheet-iron casing. A special cable coupler is used for connecting between cars, by means of which all the cables are connected or disconnected in one operation. This direct method of control has many advantages, when compared with the indirect electro-magnetic and electro-pneumatic systems. This is more especially the case now that the Board of Trade consider it advisable that motors be placed on only the front and rear carriages of a train. These advantages are:

1. Lower first cost.
2. Lower cost of maintenance.
3. Less complication, and therefore less likelihood of failure, and less delay to traffic when a breakdown occurs.
4. All moving parts of the control apparatus are directly under the eye of the motor-man, and not divided up between all the motor-cars on the train.
5. The ammeter in front of the motor-man indicates the total current used on the whole train, and not on the one car only.

On the other hand, the weakest point of the direct-control system, in the comparison, is the power cables running from end to end of the train. It should, however, be remembered that, with any system of control, a cable must be run between the collector shoes, which must be spaced far enough apart to bridge the longest crossing; also that either every car must be provided with a collector shoe, or a small cable must run between the motor and trailer cars for supplying the lights. During the six and a half years the Waterloo and City Railway has been opened the cables running throughout the trains have given very little trouble, and have been the cause of only three slight delays to the train service. In cases where trains are equipped with motors on only the end cars, and a sound system of cable troughing and reliable cable couplers are used, the direct method of control cannot fail to be, not only cheaper in first cost and maintenance, but also safer and more reliable.

The Single Cars.—Five single cars are provided for use during hours of light traffic. Each car is carried on two 4-wheeled bogies, each of which is fitted with a single reduction-gear motor driving the outside axle. Each car seats 50 passengers, and is divided by a central partition into smoking and non-smoking compartments. A small compartment for the motorman is provided at each end of the car, containing all the controlling apparatus. The electrical equipment of the cars was designed by the late Mr. S. H. Short. The motors are rated at 75 H.P. each; and the gear ratio 3·8 to 1. The controllers are of the series-parallel solenoid blow-out type, and so arranged that either motor can be cut out in a few seconds, if necessary, and the car operated by the remaining motor. An auxiliary lighting circuit of low voltage lamps, operated from a 6-cell storage battery, is installed on each car. This circuit is provided instead of the two oil lamps usually carried on every underground railway car, as emergency lights.

The leading particulars of the two classes of stock in daily use on the line are given below:

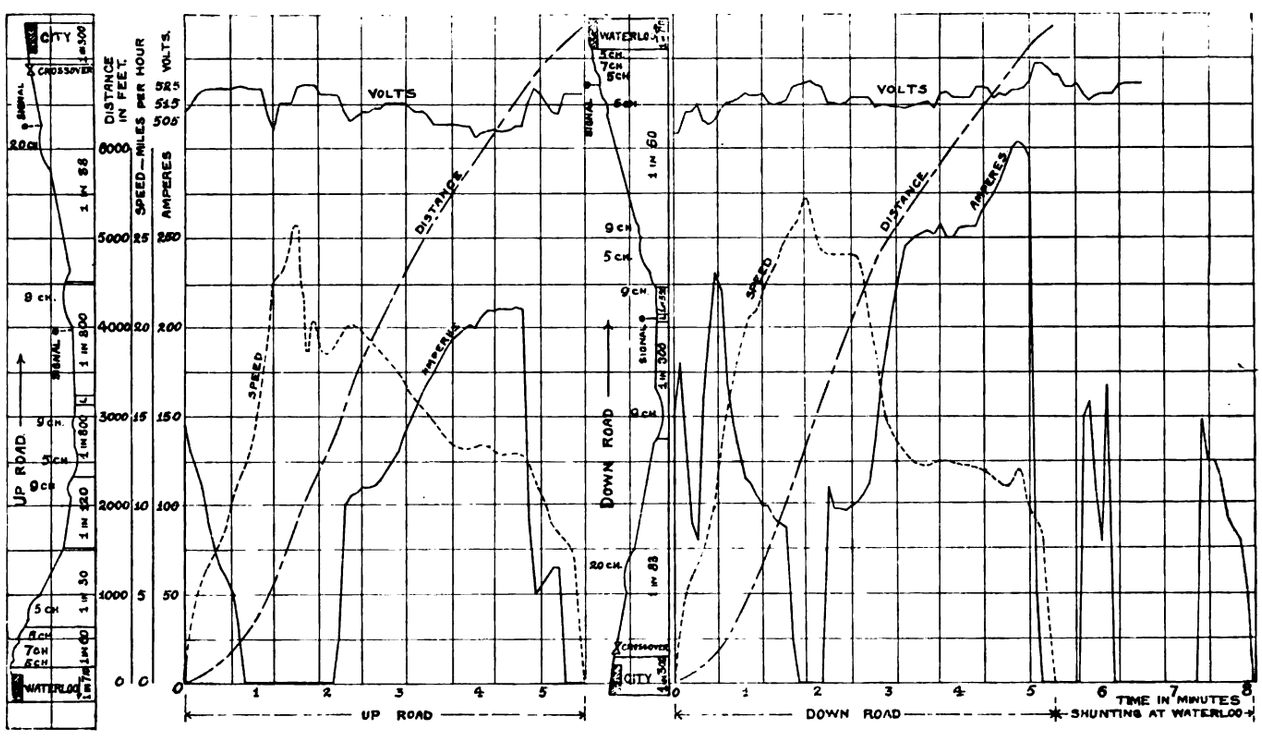

Fig. 4.—Power Curve of Four-car Train, June 3, 1904.

	4-Car Trains.	Single Cars.
Length over all	192 ft. 0 in.	47 ft. 0 in.
Width over panels	8 ft. 6 in.	8 ft. 6 in.
Height from rail level	9 ft. 8 in.	9 ft. 8 in.
Centre to centre of bogies	31 ft. 0 in.	31 ft. 0 in.
Wheel-base of motor bogies	6 ft. 0 in.	5 ft. 6 in.
Diameter of motor wheels	2 ft. 11 in.	2 ft. 9 in.
Weight with average load	100 tons	26 tons.
Seating capacity	204	50

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7.—Automatic Train Control.

The signalling arrangements are very complete, electric locking and treadles entering extensively into the scheme. A further safeguard is provided for cutting power off a train should it approach too close to a signal at danger, and also upon entering the City station and crossover siding at Waterloo. The arrangement is simple, and works so well that a description may be of interest. In addition to the usual series winding, every circuit breaker on the trains has a shunt solenoid to work across the full pressure of 500 volts. This coil is connected between the inner, or train side of the circuit breaker, and an insulated wire brush, or "slipper" carried by the equalising bar on the left side of the leading bogie. The "slipper" rubs along a piece of conductor-rail fixed 16 ft. in advance of every signal in the stations and sidings, and from 50 to 150 ft. in advance in the tunnels. This distance and the length of the bars vary according to the maximum speed at which the train could be travelling when the "slipper" engages with the bar. These "slipper bars" are set 10 in. outside the gauge and 2 in. above rail level, and are carried on insulators. A connection is made from the "slipper bar" to rails through a switch actuated by the signals, the switch being "open" when the signal is "off." Should a train run into a "slipper bar" when the signal is at danger there is a complete circuit from the circuit breaker to rails, through the shunt coil, slipper, slipper bar, and switch on the signal. This opens the circuit breaker, and shuts all power off the train. At the City station and crossover siding at Waterloo "slipper bars" are provided, which are connected direct to the rails.

8.—Air Brake Storage System.

Air for the Westinghouse brakes on the trains is supplied on the storage system. The pump room at the generating station contains,

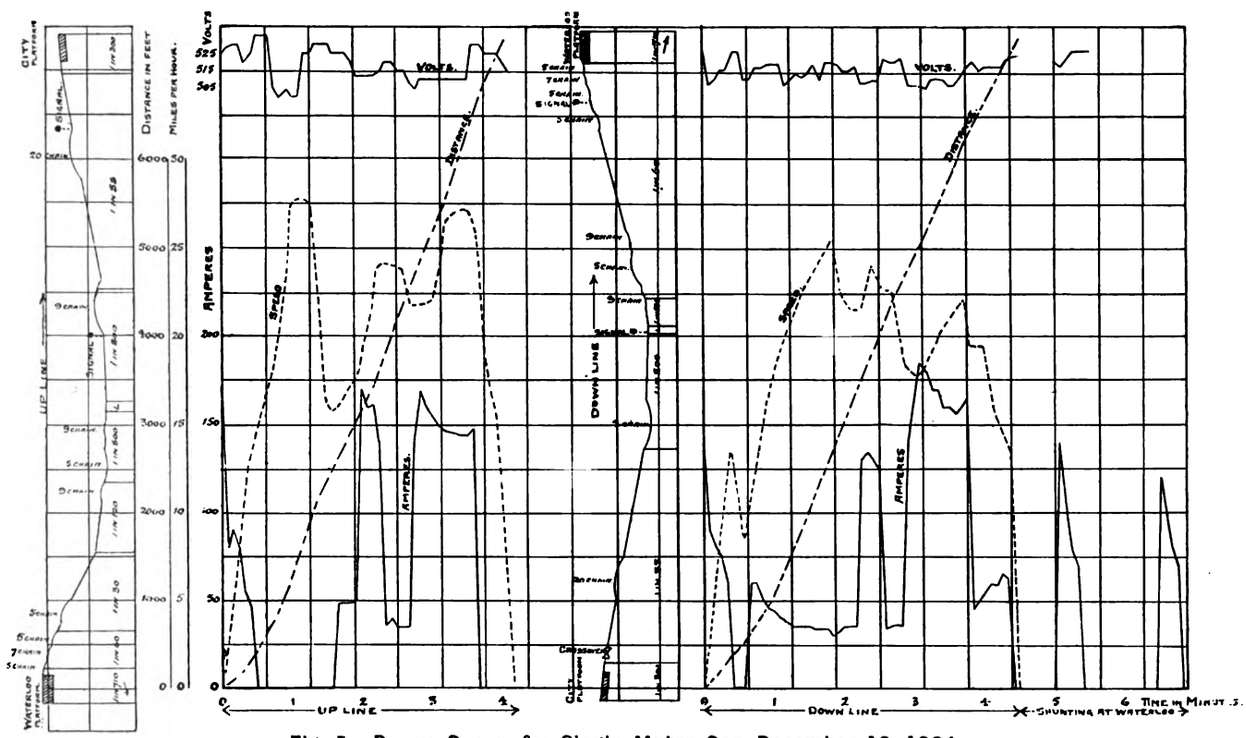

Fig. 5.—Power Curve, for Single Motor Car, December 16, 1904.

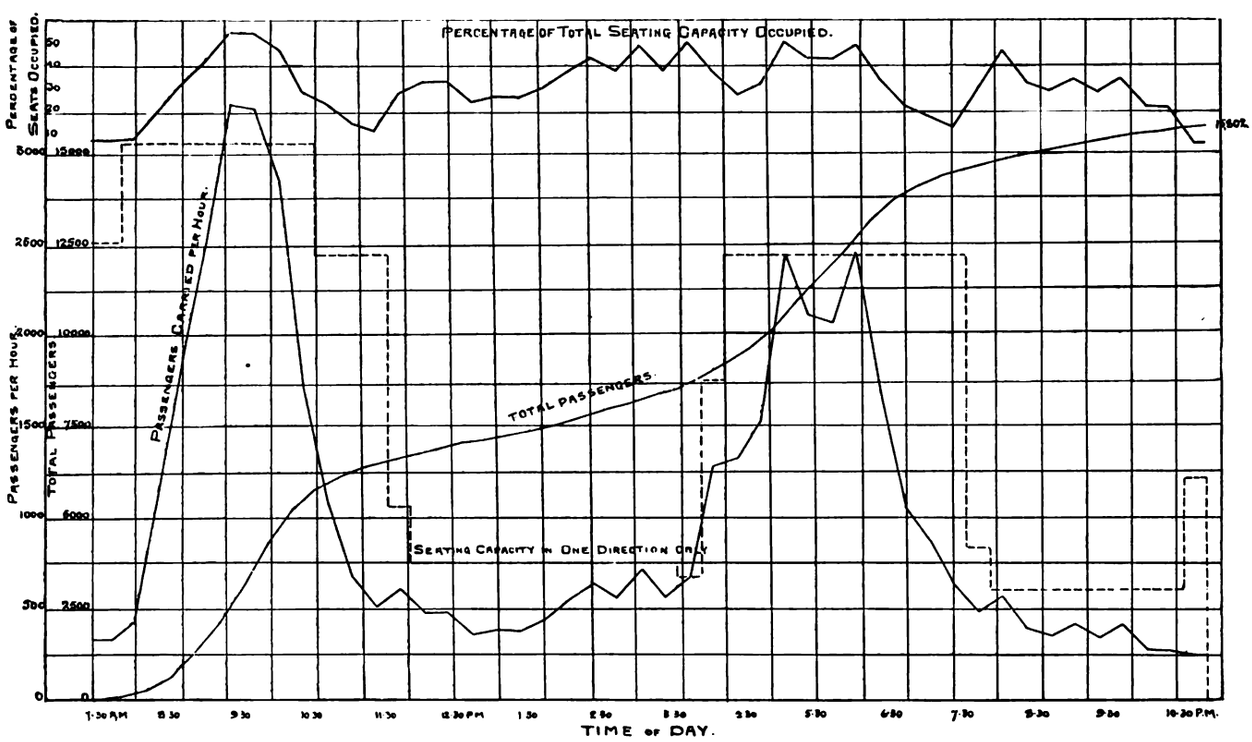

Fig. 6.—Diagram of Passengers carried on Thursday, June 23, 1904. Weather - Fine throughout.

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10-30 p.m. is due to two 4-car trains being brought from the City sidings to Waterloo as passenger trains, to be examined and put ready for traffic the following morning. The train-load factor throughout the day in question is 30·6 per cent., a result which would be practically impossible but for the use of single cars at times of light traffic. Over 20,000 passengers are carried on wet or foggy days and on Saturdays in the summer; this increases the train-load factor to 38, and on rare occasions 40 per cent. The average number of passengers carried per day during the first half of 1904 was 17,592.

10.—Half-Yearly Results.

The following figures include all losses, such as coal used for stand-by and lighting-up purposes, and water used in the filling up boilers and economisers after cleaning:

1. Period	Half-year ending June 30, 1904
2. Total coal used	2,742,992 lb.
3. Total water to boilers	24,192,900 lb.
4. Average temperature of feed-water to boilers	172 deg. F.
5. Actual evaporation per lb. of coal	8 82 lb.
6. Equivalent evaporation per lb. of standard coal from and at 212 deg. F. (excluding economiser)	9·56 lb.
7. Total units generated	499,512
8. Water to boilers per unit	48·4 lb.
9. Coal to boilers per unit	5·49 lb.
10. Units used for traction purposes	350,570
11. Train ton miles	6,023,610
12. Units per ton mile (at switchboard)	0·0582
13. Coal used per ton mile at switchboard	0·319 lb.
14. Number of passengers carried	2,726,760
15. Units per passenger mile (at switchboard)	0·1221

The time lost during the half-year in breakdowns and delays from all causes was 0·16 per cent. of the total running time, which amounts to a total delay to trains averaging about 8 minutes per week. This result is poor when compared with the corresponding half of 1903, when the figure was only 0·09 per cent., or a total delay of less than 5 minutes per week. These results are obtained under the exceptional conditions that for 3 hours daily all the 4-car trains provided are necessary to maintain the service, so that a defect which makes it necessary to take a train over pits, causes possibly four or five journeys to be missed subsequently, which is considered as equivalent to a delay of 16 or 20 minutes. Additional siding accommodation is now being provided in order that the spare cars may be made up into a spare train. During the half-year the total number of train miles was 92,304, of which 48,939 were 4-car train miles, and 43,335 were single car miles.

11 Costs of Working.

The works cost per unit generated during the half-year ending June, 1904, is given below. Management, directors, and office expenses, etc., are not included, as the allocation of these charges between the several departments of a railway is a matter upon which there is considerable difference of opinion. The number of units generated was 499,512.

Works Cost per Unit Generated, in Pence.

Coal, including delivery	0·527
Water, oil, and other stores	0·032
Wages, including engineer-in-charge	0·296
Repairs and maintenance	0·064
	0·919

Receipts and Expenditure per Ton Mile. The total receipts per ton-mile during the half-year ending June, 1904, were 0·692d., and the total expenditure 0·329d. The working expenses were at the rate of 47·55 per cent. of the receipts, a figure slightly above the average of the last three years. The following figures give the cost in pence per ton-mile in connection with the generating station, distribution system, trains, and motors:

Generating station running, including wages, coal, water, oil, and petty stores	0·071
Generating station, wages and materials for repairs and renewals	0·005
Distribution, wages and materials for cables, conductor rail, rail bonds, and tunnel pumps	0·004
Running trains, wages and materials for motormen, examiners, and cleaners	0·044
Car and motor repairs, including wages and materials for all train and motor repair work	0·020
	0·144

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TRAMWAY OVERHEAD EQUIPMENT MATERIALS.*

By Mr. H. M. Sayers, M.I.E.E.

This audience is well aware of the general purposes to be fulfilled by a satisfactory overhead equipment, but to make an orderly study it is necessary to commence by a brief analysis of the mechanical and electrical conditions which must be satisfied in order that the structure may serve its purpose with the maximum economy and efficiency. The necessity of studying appearance should not be a serious addition to the primary engineering necessities, for the appropriate use of materials and obvious adaptations of means to ends satisfies the æsthetic as well as the practical sense and, where incongruity with architectural and natural beauties is the danger, unobtrusiveness will probably give better results than any elaborate attempts at ornament.

The first mechanical condition to be satisfied is evidently that of safe and stable support. The trolley wire has to resist, in addition to the stresses on a suspended wire, the repeated upward thrusts of the trolley pole and the friction of the trolley wheel. The attachments are exposed to reversed stresses of the nature of blows in both vertical and horizontal directions, and the wires being necessarily carried at a distance of several feet from the poles any unbalanced longitudinal stress produces considerable couples upon the supporting structure. The second mechanical condition is that imposed by the function of the trolley wire as a suspended guide or rail for the trolley wheel to run on. This condition resolves itself into a necessity to follow the general lines of the rail track in plan - with some maximum permissible lateral deviation, and some maximum permissible change of horizontal direction at points of support. The permissible limits in both directions depend upon factors outside the overhead structure, some of them being the type of trolley boom and wheel, the size and speed of the cars, the radii of the curves, and the lay-out of junctions or other special work.

The effects of wind and snow are of relatively small importance as regards trolley wires, but must be given full weight in the erection of guard wires. The electrical conditions to be met affect the mechanical structure in so far as they prescribe the size and weight of the trolley wire, the necessity for efficient insulation being constant.

Time will not permit of more than quite general references to questions of design and erection of the line, excepting as they may affect the choice of materials and design of parts. I therefore take the different items of material in an order which is intended to be logical and consequent.

The trolley wire comes first, its support and proper position being the principal object of the whole work. The stresses on all the supporting structure are evidently functions of the size and weight of the wire used, and to keep down the size, weight, number, and expense of supports the wire should be chosen as small as will serve the designed purpose.

It is easy to show that there is no electrical necessity for using any wire larger than No. 0 S.W.G. (·324 in. diameter), where the trolley wire is fed as usual from underground feeders at half-mile intervals, unless the traffic is extremely heavy. But on suburban or interurban lines carrying an infrequent service it may be necessary to avoid the expense of underground feeders, and to employ heavier trolley wires, or preferably overhead feeders. Heavy traffic over curves of short radius may also afford a reason for the use of larger wire in order to increase the life, and remove the risk of breakage on account of heavy mechanical wear.

The most economical size of trolley wire to employ in any particular case is thus mainly a question of its life as a mechanical wearing part, the cost of renewal and the loss by scrapping having to be put against the capital expenditure. But it must not be forgotten that a heavier wire involves heavier poles and other supports, the cost of which must be properly brought into the account. The conditions are too complex, and at present too little determined by experience, to admit of the formulation of any general rule, but it is probable that where the conditions are very severe it is better to employ one of the harder bronze alloys than a copper wire of large size.

One reason for this is that the wearing qualities of hard-drawn copper wire are not directly proportional to its weight, the hardness diminishing from circumference to centre. This is well shown by the fact that the Post Office specification for such sizes as Nos. 12 and 14 calls for a breaking strain of 28 tons per square inch, whilst the usual trolley wire specification is equal to 22 tons, over 20 per cent. less. The effective thickness of the hard skin varies with the details of the manufacturing process, and very little seems to be known about the subject by users; but, from the behaviour of trolley wire under long wear, it seems probable that the hardness diminishes gradually and, up to such sizes as No. 0, a considerable thickness is appreciably hardened. It is also possible that the rolling of the trolley wheel has

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satisfactory permanent insulating sleeve for the clamp in this climate, all materials tried, so far, failing in a comparatively short time. The "bowstring" suspension is an improvement, but it is still far more rigid than the span wire, and, therefore, results in greater wear of wire and trolley wheels, and in deterioration of insulators, besides leading to de-wiring at speeds much lower than can be run with safety on span-wire work.

This detrimental effect of rigid or semi-rigid attachments is sometimes overlooked, or the true cause is not recognised, although it is simple enough. The trolley wheel of a moving car presses the trolley wire upwards with a force which usually equals or exceeds half the weight of the span of wire. At the centre of a span it will therefore lift the wire considerably, possibly to the height of the points of support; from the centre onwards it is, however, depressed with increasing rapidity as the stiffness of the wire comes into play, and will be below the level of the ear some distance before it arrives there. It therefore meets the rigid ear while rising rapidly, and delivers a blow the force of which is the product of the effective mass of the whole boom and head, and the square of its upward velocity. At some speed the rebound will take the wheel flanges clear of the ear, and, if there is any side pressure, de-wiring results. The noise and the flash invariably seen on the passage of trolley wheels under bracket-supported hangers demonstrate the correctness of this explanation. After passing the ear the wheel at first descends, but soon commences to rise again up to about the middle of the next span. Its path is therefore a wavelike one with a high crest in the middle of each span and a small steep one at each ear. Besides the effect of the blow upon the ear, the insulating materials, and the trolley wheel and boom, the wire is worn by arcing and damaged by bending. It is therefore not extraordinary that failures of insulators and breakages of wire at ears are more common on bracket than on span-wire work. If bracket-arm construction is used, the bowstring should be made as long as practicable in order to get the maximum flexibility.

The flexibility of a span-wire construction greatly reduces the blow upon the ears, as the span wire also rises to the trolley pressure, and the ear more readily aligns itself with the wire but, at high speeds, the effect is quite perceptible and, for railway speeds, the longitudinal suspending wire carrying the trolley wire by hangers at short distances and so approximating to a system with a constant vertical rigidity from point to point is essential.

Span, bowstring, and pull-off wires are generally of galvanized steel, but in many towns this material has but a short life on account of atmospheric pollution, and, in such cases, phosphor or silicon-bronze wire should be used. This applies equally to guard wires and their supports; whichever is used the metal parts of the suspension fittings should be of similar metal. There is no means of preventing galvanic corrosion where dissimilar metals are in contact, and such contact should be avoided. The use of iron insulated bolts screwed into brass ears is almost universal, and frequent trouble results at this point. Gun-metal bolts would be better, but there is some difficulty in getting them made.

The size of span wire should not be less than 7/14 S.W.G. There seems no reason for using larger wire, but such use is quite common even up to the monstrosity of 19/12. This wire should have a breaking point equal to from 35 to 40 tons per square inch after stranding; the galvanizing should be carefully examined and tested in the manner prescribed by the Post Office. Galvanizing that is originally defective, or that cracks and peels off in erecting, is useless, the wire will rust through at the unprotected points in a brief period.

To secure the wire at the poles it should be laid around a horse-collar thimble of size proportioned to the size of strand, and properly bound with galvanized charcoal wire—not twisted up. Better than the thimble is a shackle or reel of porcelain with a central hole to take the strap bolt. Porcelain is a far better, more durable, and cheaper insulator than any of the compounds used in turnbuckles, globe strains, etc. There is no need to provide any tension adjustment at the ends of span wires—insulated turnbuckles, Brooklyn strains, etc., are quite unnecessary, and represent wasted money. With a dynamometer on the drawvice, or by the measurement of the sag from the ground, span wires can be put up with the greatest uniformity, and the certainty that the trolley wires will be carried at their correct level. This level can be checked, if desired, by loading the span wires at the correct points with weights representing the working load, but this only needs to be done once for each width of street.

Bracket arms are generally made of 2-in. steel steam tube either screwed or expanded into a socket on the pole clamp. These arms are often much too long for safety. A 2-in. tube 12 ft. 6 in. long, fixed as a cantilever, and loaded with the weight of a span of trolley wire and the suspension fittings, is very near its breaking point. Longer arms are therefore entirely dependent upon tie-rods. The longer the arm the less efficient the tie-rod, owing to the more acute angle between the two members. As generally made, tie-rods are pulled up by a nut so that their effective strength is the resistance of the threads to shear. Bracket arms 18 ft. and 20 ft. in length are therefore extremely unsafe, having practically no margin of safety. It is better to use eye-ended tie-rods and dispense with nuts, and no real difficulty arises in erection if the clamps are fixed at measured distances, so that the brackets and tie-rods make the correct calculated angle; but if adjustment is necessary it is best provided by a long, solid, right-and-left threaded sleeve fitting the two parts of the rod like a rigging screw. Struts are usually inapplicable, but if the scrollwork can be made to give some support so much the better. Bracket arm pole clamps should be of substantial length, and a good fit on the pole by internal fitting rings at top and bottom. The bolts should fit through long bored sockets in the planes of the fitting rings, and be kept close in to the poles. The socket receiving the arm should be of ample length, and well thickened out to the body of the clamp. In fact, in designing bracket arms and their fittings, the stresses and strains should be calculated out as for a loaded cantilever, ignoring the tie-rod, but adding 50 per cent. to the dead weight to allow for the rolling load and its hammering effects. Then the tie-rod and its fastenings should be designed to carry the same load safely. Malleable cast iron is the best material for pole and bracket arm clamps and bowstring brackets. These last are often too short to give proper clearance, and are spaced too close on the bracket to give the elasticity so desirable. They should be pinned or otherwise secured so that they will not slide along the arm. Porcelain shackles should be used as the secondary insulation of bowstrings. Care should be taken to provide ample clearance above the cap of the hanger. Sometimes only a small fraction of an inch is left between the cap and the bracket arm tube, with the result that at every passage of a trolley wheel the hanger strikes the arm, damage soon resulting.

On straight work the "straight line" hanger is the best insulated fitting, but on curves and wherever there is a probability of lateral pressure on the wire the pull-off pattern must be used. The caps of these should be provided with some form of locking device, and a soft leather washer should be placed between the head of the insulated bolt and the cap. The insulating material on the bolts is far from perfect. The compounds are trade "secrets," but very slight investigation shows that shellac is the insulating and consolidating element in nearly all. Mica, asbestos, and other mineral substances add some toughness to the mass, but its mechanical qualities are generally poor. Whilst new the insulating qualities are very good, but in a short time the atmosphere deposits dirt on the exposed surface, and sooner or later in damp weather a trifling leakage of current chars the surface and breakdown speedily follows. This should not happen if the secondary insulation remains good and, if porcelain is used, such breakdowns are very rare, because a porcelain surface does not char with a small creeping leak, it dries up and the leakage ceases. A somewhat tough vulcanite has been introduced. Vulcanite has had extensive trials in telegraph practice and obtained a bad reputation. Tramway conditions are less favourable to its permanence. This matter is really a serious one, and the insulated bolt is probably the most unsatisfactory item of the whole overhead equipment. The cure may be found in redesigning the arrangement in such a way as to remove the insulator itself from so trying a position, but there are obvious difficulties. The usual practice of keeping the two trolley wires for up and down directions separately insulated and separately fed is highly advantageous. But at junctions this becomes very difficult. Insulated crossings are a variety best avoided and, as above stated, the best course is to feed junction-work separately; the next best thing is to feed it through one wire only of one of the junctioning lines, and to insulate the junction from all the other wires.

The soldered ear is the best form of attachment for the trolley wire. Many patterns of mechanical ear have been devised and tried, but it is hard to see how any mechanical clip can give equal security without adding to the effective diameter of the wire on the arc in contact with the wheel. The use of wire of figure 8, or grooved section, makes the mechanical ear satisfactory, but such wire is at once more expensive and more troublesome to erect, so that the balance of advantage remains with the soldered ear. The metal used for ears should be a tough bronze or gun-metal, and careful inspection after machining is necessary to eliminate defective pieces, as the castings are somewhat apt to show blowholes and other weak places. The groove to receive the trolley wire should be milled to a hundredth of an inch larger diameter than the wire, and should come to a sharp edge. It is doubtful whether the small lugs, which it is usual to provide at the ends of the ears for hammering over the wire, serve any useful purpose. They sometimes hold up a wire that has not been properly soldered until traffic commences. Fifteen inches is the minimum length of ear for straight work, the tendency is to increase the length up to as much as 24 in., but the advantage seems doubtful. On curves longer ears are necessary, and by bending them to a proper radius the change of direction of the trolley wheel is much smoothed. Unfortunately curved ears tend to pull into angular shape with use. There seems no good reason why they should not be cast curved with lateral webs to impart stiffness. It would not be necessary to use many different radii, as the varying radii of the track curves should be met by the use of a larger or smaller number of pull-offs, with a standard deviation at each. Splicing ears should not be needed in building a new line, but are necessary for repair work. They are rarely well designed, the wire ends having to be bent too sharply, and some patterns are provided with foolish little steel set screws, that invariably rust fast and break off. Anchor ears should be provided with stout eyes of rounded

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section, to which the anchor-wire can be secured without bending to a dangerously small radius.

Section insulators present a combination of difficulties, and in selecting a pattern both mechanical and electrical considerations must be studied. The pull of the wires has necessarily to be transmitted through insulating material, and it ought to be so transmitted as a straight pull without any binding or twisting component. This is inconsistent with the necessity for allowing a straight level path for the trolley wheel. Hence the best designs are but compromises, and the worst may be guaranteed to break down within a few months. The terminating arrangements for the wire ends need the same easy curvature as in splicing ears. It is better to dispense with set screws for securing either the feeder cable or the trolley wires and to have tinned sockets or grooves into which they can be soldered. The air-gap pattern is probably better than that with a gap stick, but there should be two distinct air-gaps, and an insulated running piece between them, to prevent an arc being drawn in the event of an earth on one wire. Gap sticks of lignum vitæ have been found to wear smoothly and give a regular life. Section insulators are very heavy and saving of weight is a merit to be fully credited. Easy and rapid replacement is another virtue which will be appreciated when the line is at work. The sweating of the connections is not inimical to this because, knowing that it has to be done, the fire-pot and bit will be ready, but a rusted-in set-screw cannot be calculated for. An advance copy of this paper has brought for inspection a section insulator, designed by Mr. Frank Hewer, which has a business-like appearance, and which meets some of the objections to earlier patterns, though I do not think it quite perfect. But I expect that some of you have used Mr. Hewer's insulators and can speak of their virtues. Those who have not will be interested to see this sample.

Junction special work fittings also require careful selection. For central wires and rigid trolley heads the frog makes a satisfactory facing point, provided that it is properly set, with reference to the track points, and the lengths of the cars and trolley booms. Even with swivelling trolley heads frogs will work fairly well if the wire is approximately central but, for side wires, switches with movable tongues should always be used in the facing direction. Frogs will work on side wires in the trailing direction, but must have deep cheeks and grooves to take the wheel flanges, as there is a considerable centrifugal force tending to de-wiring and automatic or spring switches are preferable. Crossings are apt to give more trouble than frogs or switches. The greatest care should be taken to get them of the correct angle to suit the track crossing, but as the angle is also affected by the lengths of car and trolley boom, the junction should be drawn to scale, a template of the car and trolley boom fitted to it in successive positions to ascertain the best angle and position for the crossing. Even with a central wire there must be a lateral pressure on the trolley wheel taking the junction curve, so that guidance by the flanges across the gap is necessary. A swivelling trolley head adds largely to trouble at crossings by its liability to turn while crossing the gap, and this liability is aggravated by any considerable side reach. At junctions on single lines it is best to use only a single trolley wire and thus avoid the use of crossings, especially if swivelling heads and side wires are used. It involves the use of three automatic switches, but these give much less trouble than one crossing. All these fittings should be so designed that the trolley wires need not be cut when fixing them, and so that they can be securely held by pull-off and span wires to their positions.

Feeding arrangements are usually classed with the overhead equipment, the feeder work terminating with the thimbles entering the bus-bar terminals. As regards the feeder pillars the best advice is to make them as big as will be tolerated. Even at this they are pretty sure to be awkwardly cramped. Opinions and practice are divided between cylindrical and rectangular shapes. Perhaps it is largely a matter of taste. The cylindrical pattern gives the largest amount of useful space for the area covered and for the weight of the casting, and has the practical advantage that when opened the panel is somewhat more accessible. On the other hand the fitting of the curved doors is not so good a job as with the flat-sided pillar, and when the doors are closed there is less clearance between them and the live parts. Provision should be made for ventilating the pillars without permitting the entrance of rain or snow: the bottoms should be filled in over the concrete with a thick layer of pitch or bitumen, and all leading in pipes stoppered. The safest kind of panel is a cast-iron frame into which are cemented porcelain insulators carrying the live-metal work, the frame being itself carried from the sides of the pillar by oil insulators. It should be easily removed for replacement by a new panel. All the cable connections should be made on one side of the panel, the switch fittings being on the other.

Plain quick break switches are frequently used and answer most purposes but, where a number of feeder pillars are fed by one cable feeder, the use of switch fuses, such as the Bates' pattern, will sometimes isolate a faulty length of trolley wire and avoid the stoppage of all the sections served by the feeder. As these switch fuses are not dearer than the quick break knife switches, and have no troubles of their own, they should be chosen, although in most cases the feeder circuit breaker will outstrip the fuse.

All cable ends should be terminated with corrugated porcelain stoppers suitably sealing the dielectric. A kicking coil and lightning arrester are necessary to protect the underground cables. Three or four kinds of arresters are in use, and there is not much to choose between them. I think the Garton is perhaps the best. They all get blown to pieces occasionally, either by a lightning discharge, or the short set up by it. Telephone fittings are generally included in feeder pillars. They should not be fixed on the switch panel, but quite separately, and surrounded by an earthed metallic frame to protect them from leakage. The same treatment is best for the pilot wire terminals that may be provided. Telephones do not thrive in feeder pillars, and there is rarely any room for them. The provision of a socket box into which the cords of a portable set may be plugged is therefore the best arrangement. If fixed telephones are thought essential they should be placed in separate pillars, or in boxes secured to the poles.

The side-feed cables from the feeder pillars to the trolley wires are often troublesome, the trying conditions and their importance are such as to warrant careful design and erection. In many cases small holes are drilled through the pole underground and above the span wire or bracket attachments, and the unfortunate cables threaded through these holes with the slight protection of a wooden or fibre bush. It is impossible to tell how sharply they may be bent, or how much they may have been strained in the process, but experience shows that they are frequently damaged and have in consequence but a short life. Their replacement, in case of need, is a particularly tedious and exasperating job. The following has been found a good method of dealing with this matter. An oval hole about 4 in. by 5 in. is cut in one side of the pole about a foot below the ground level, and a special quarter bend of 3 in. pipe passed into the pole and bolted through a flange which fits its periphery. This 3 in. pipe finishes in the base of the feeder pillar with a bell mouth providing a duct of ample diameter and easy curvature for the passage of the four cables. The pole is fitted with a special finial made in two parts.

The lower part fits easily into the top of the pole supported by a narrow flange resting on the pole end and expanding upwards and outwards to form the ornamental base collar of the finial. The portion inside the pole carries four screwed glands provided with rubber gasketts, and bored to pass the cable. Screwing up the glands secures the cables by compressing the rubber packing rings. Four holes are cored out in two opposite pairs, through the bottom of the flared out part, through which the cables descend outside the pole. This fitting is wired by passing the four cable lengths through the glands and then by an easy and regular curve, through the holes in the wide part. A hauling wire having been threaded down the pole and into the section pillar, the long ends are drawn through the pole and the fitting rests on its place. The upper part of the finial is merely a cover shaped to match the other pole finials, and secured by two tap bolts. The outside cables are secured to the pole by a suitable clamp and then taken by an easy curve to the span wire or bracket. This arrangement is safe for the cables and, in case of need, their replacement is a very simple and speedy operation. It is almost essential to use indiarubber insulated cable, as the dielectric must be waterproof and flexible. Flexible metallic tubing has been found a suitable sheathing. It adds little to the diameter and weight; it is very flexible up to a certain point, and then refuses to bend further, which is a safeguard to the cable. The metal sheathing of the cable should not touch the trolley span or bowstring wire, and should therefore be cut well back. On span-wire work it is best to carry the feeder cables on a separate span wire above the trolley wires. This should be insulated in the usual way, and the sheathing cut back from it. The cable ends then dip down very conveniently to the section insulators, and there is a long surface of cable covering free in air, over which very little leakage can occur. The cable terminals here should be made with corrugated porcelain stoppers as a further precaution. On bracket arms the cables should be secured by special collars fitted with ebonite bushes, and arranged to give the longest possible leakage path.

Guard-wiring is a necessary evil in this country, as tramway undertakers can neither compel the owners of overhead wires to make alterations to them, or even prevent the erection of new wires over an existing trolley line. Galvanised steel wire, No 8 standard gauge, satisfies the requirements. Solid wire is better than stranded, having a longer life. The same wire may be used for guard-wire spans. Guard wires should be run over the span wires and secured to them by binding wire sweated at the ends of the lappings. In some atmospheres it is necessary to use bronze instead of steel wire. On bracket arm work, a span wire from the pole to a standard clamped to the end of the bracket makes the best job, but a neat and good-looking arrangement is hard to find. Secure erection is often neglected for the sake of light or ornamental appearance, with sad results.

Telephone and pilot wires are sometimes run on tramway poles. Hard-drawn copper is the best material. Good telegraph practice should be followed in the design and attachment of the insulators, but a somewhat freer use of shackles is sometimes desirable. These wires are sometimes carried on the trolley or guard-wire span wires, but it is difficult to make a good job of this. No. 12 wire is usually large enough; smaller sizes are too weak. They should be carried at such levels and positions that they cannot be blown across the trolley wires

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if broken in a gale. The speaking on these telephone lines would be improved if they rotated after the manner of Post Office trunk lines. They generally suffer much from trolley-wire induction.

Overhead feeders have sometimes to be provided for. They have to be carried from suspender wires and to be covered, best done by hard cotton or hemp braiding saturated with waterproof preservative compound. These conductors should be shackled off at every pole. If they are large it will be necessary to increase the size and stiffness of the poles used. As regards appearance such feeders are very objectionable, and they complicate the overhead engineering considerably, especially at feeder poles. But the saving of underground work is oftentimes an important economy, and a perfectly good job can be made.

Time and space limit this discussion to matters of material. Much might be said on erection, but I have probably said quite enough for one time. There must be now a good deal of information available as to the normal life of various items of overhead equipment under various conditions of traffic and atmosphere; and also as to the nature and frequency of breakdowns. Mr. McElroy last year made a laudable attempt to collect some of this information, and I am considerably indebted to the paper which he prepared for the last conference of the Municipal Tramways Association. This, however, is only a beginning, and only partial because, for some reason not easy to understand, no information was given to Mr. McElroy by any tramway company's officials. It is by the collation and discussion of information from all sources that advance may be expected, and every little helps, so the continuation of Mr. McElroy's good start is highly desirable.

The cost of overhead work seems to vary a good deal more than it should. Some authorities put it at £1,500 to £2,000 per mile of route, but I don't know how so much can be properly spent. Thoroughly good span-wire work for either double or single lines can be erected for £1,200 per route mile, with fair profit to the contractor. Bracket arm work, for single lines, where a single line of poles is generally sufficient, can be done for £1,000 per route mile, or even less under specially favourable conditions. These rates include average amounts of guard wiring and proportion of junctions, but very heavy and complex junctions, car-shed fan-work, and similar special requirements will involve some additional expense. A great deal of money can be spent on elaborate scroll-work and fancy painting, especially if a little goldleaf is thought necessary to harmonise with the surroundings; but these are matters of taste rather than engineering, and those who like to pay for them will doubtless continue to do so.

In some towns there certainly is the excuse that the overhead structure is the only thing visible in the streets that bears the slightest trace of design or grace, of which the most should, therefore, be made.

Discussion.

Mr. W. M. Mordey said that it was on matters of detail such as were dealt with in this paper that the greatest difficulty generally existed in getting reliable information based on experience. There was a distinct field which could be filled by the author—for a really good detail book on tramway construction—a book dealing fully and carefully with the subject from an engineering and workshop, linesman's and trackman's point of view. There was a great deal of information in this paper in a condensed form that could very usefully be worked out in detail in such a work. They might congratulate themselves that although late in starting they had done better tramway work than any of the countries that set an example by starting earlier. Mr. Sayers had referred to the use of centre poles, and pointed out that they were a nuisance and a danger. This was true both for tramways and for lighting. Lines of posts down the middles of busy streets often took away a third of the usefulness of the streets. So far as appearance went, wood poles were seldom satisfactory and, as to cost, it was not always remembered that reconstruction might make wood more costly than iron poles. He was rather surprised the other day in one of our large electrical factories to find that for oil-switch work there was a return to vulcanite insulators for the support of the metal parts in the oil, and he was told that under such conditions the vulcanite insulators did not deteriorate on the surface, that they did not crack, and that they were more durable than porcelain. Mr. Sayers had not mentioned one of the most largely used insulators in the world, the United States glass insulator with a wooden stalk, which had never found popularity in this country. Was this difference because our climate was moister and more condensation took place on the glass? He would have thought that the difference in that respect between a glazed insulator and one made of glass would have been small. At any rate, there were mechanical reasons why we were better without the wooden stalks. The author had not referred to the V insulator or fork lightning arrester—the arrangement of two wires that are spread out like a V—an arc started at the bottom being carried up by magnetic repulsion as well as by the current of air. It had been found possible, by that simple means, to protect lines which went through open country at altitudes of 4,000 to 6,000 ft., through bare country without any trees, and where there was nothing to act as a protection to the wires.

Mr. A. J. Lawson (referring to the proposed standard poles) said he thought the first pole was much too light. All the suggested poles were too light. The diameters were too small—a very slight increase in the weight, with an increase of diameter, would have given a stronger pole. The weakest section of all was the bottom section, which was subjected to the greatest stress and to the greatest corrosion, and had not a factor of safety in some cases of more than two and a half with ordinary strains. He had, within the last three years, put up a great number of poles heavier than the proposed standard, and they had not been satisfactory. They had bent from the ground line upwards, and the heavier poles had given way at the top joint, and sometimes at the second joint. He would suggest that what was now the medium pole (if they would adhere to half inches instead of going to inches) should be the No. 1 pole: that which was called the heavy pole should be the medium pole, and that a pole weighing something like 1,270 lb. or more should be No. 3 pole—the strongest—and that the diameters should be 8, 9, and 10 in. The section insulator which Mr. Sayers showed had been redesigned with a straight underline, and he had used it for the last three years, almost exclusively on some fifty miles of track at least. He had never anchored any wire attached thereto. He had this objection, however, to the insulator—at least to the insulating material—it decomposed, it cracked, and sometimes the makers themselves in putting it together used gas tongs or some tool of that kind and broke the insulating surface. That section insulator with proper insulating material was, in his opinion, the best that he had seen. Regarding porcelain insulators as secondary insulators, they were very good, provided they were of sufficient strength; but they had to be properly designed. Ordinary stock insulators were not strong enough, and gave a lot of trouble. He thought toughened glass would be better still. The best overhead construction, in his opinion, was the span wire; it was the most flexible, the easiest running, and gave the least hammering. In Birmingham, where he was compelled to adopt bracket-arm construction on each side of the street on some miles of double track, a very peculiar effect was produced, for occasionally there were centre poles and occasionally span wires. Ostensibly the bracket-arm construction was insisted upon in order that fire escapes might have a clear run through, and they could imagine what the result would be with first centre poles and then span wires, when the fire escape attempted to pass through (which was, however, very rarely the case), but the cost was increased by about £100 per mile, and now the general manager of the Birmingham tramways insisted that all new work should be on the span-wire principle! Poles were very often made unsightly by scroll work. His own idea of proper overhead construction was a pole nicely designed, and with nice finials and columns, and no scroll work at all, with a plain span wire and as plain construction generally as they could possibly get. Regarding cost, he had put up some 30 to 40 miles of line—doing the work without a contractor, simply paying for labour at the current price in the district, and purchasing material in the open market, and did not think there was a fair profit to the contractor who had to bear certain office and administrative expenses in £1,000 a mile or in £1,200 a mile. He thought Mr. Sayers should allow at least another £100 a mile. He was speaking of the total cost, and included in that the raising of the telephone and telegraph wires.

Mr. W. H. Booth asked Mr. Sayers if he could give any information on the question of the bow trolley, and some idea of the relative advantages of the two types of trolley, and also something about galvanising, and the proper preparation of wire for galvanising. He would like to know if there was anything better than pure zinc for galvanising. It seemed to him that something softer would be better. Mr. Sayers had referred to the lapping of the joint round the horse-collar by charcoal wire, which was, perhaps, preferable to nozzling; for when the men finished the nozzling, they took hold of the nozzle by means of pincers, and worked it round and round for the sake of consolidating the wire. This scraped off the zinc, and that meant practically taking off, perhaps, three years' life from the overhead equipment on the day that it was put up. Another point was that they were always accustomed to put up the overhead system on the principle of a harp. Everything was stretched as much as possible. Was there any objection to allowing the span wire more dip? The strain would be considerably reduced if the span wire were put in with a considerable amount of dip. As to poles, why should not the pole be made with a collar at the ground level about 9 in. long, which would only add a few pounds to the weight, but would add many years of life to the pole, as it would take years to rust through the collar at the floor-line.

Mr. W. H. Turner said that in fitting up an electrical apparatus for automatically operating the tramway points in High Street, Sheffield, he found it necessary to drill the pole at the bottom, about 12 in. below the road level, in order to bring the cables down the pole into the box, and as soon as the drill pierced the pole it was seen that water had somehow got into the pole to a depth of at least 6 in. above the road level. How it got there he had never been able to find out, but he thought probably that the finial at the top had been left off during construction, and that the water had got in that way. With respect to trolley-wire breakages, these in most cases happened where soldered ears were used. He believed that with the breakages on the Leeds city tramways, that had been found to be the case, and grooved wire and mechanical ears were now being installed there on the busiest routes.

Mr. E. W. Dickinson said that he had a little experience some years ago in which some American engineers had specified wooden poles for a lighting job in the tropics, and poles were sent over from America

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made of very soft pine. The result was that in about three years, at the base of the pole the only useful timber left was about the size of a pencil. But they replaced these with native pine and balata, and he thought if timber were carefully chosen to satisfy local conditions, it would be found to last ten or fifteen years. Regarding ears, he thought that the process of soldering tended to soften the trolley wire for one thing, and the general tendency at present was to go in for mechanical ears, using grooved trolley wire.

The CHAIRMAN (Mr. A. L. C. Fell) said he failed to see why the General Post Office and the National Telephone Company should be allowed to put up unsafe wires and call upon the tramway authorities to protect the public. That was a great point which the tramway authorities should take up. There was a case just before he left Sheffield, where the guard wires were perfectly put up. The guard wires and the trolley wire were new and perfectly clean, but unfortunately the Post Office wires overhead came down on top of the tramway wires, and were covered with soot, and they wrapped round the trolley wire and guard wire, and instead of earthing as they should have done the bad contact caused arc. The Post Office fuses, which were put in specially, failed, and the instruments in Manchester were burnt out. That was entirely due to a defective overhead telegraph wire, which really should have been underground. With regard to the point about the No. o S.W.G. trolley wire, although there might be no electrical necessity for a larger trolley wire, it appeared from the records of the country that, in the majority of accidents to trolley wires, the break occurred more frequently where a single o trolley wire was used than with heavier wires. In America and on the Continent the single o trolley wires had been generally used, and they were going in for a larger wire now, and accidents were less frequent. He found that if they got the original bar rolled rather larger and gave the trolley wire an extra draw through the vice they could increase the tensile very much without decreasing the torsional test. It was well worth paying a little more money to get that done rather than putting up a larger wire. With regard to bronze and other special wires, he had put up a great many miles of them, and he found that, although the wires had a much higher resistance, it paid over and over again to put up a special high resistance wire with a high tensile test at important junctions, and to feed it separately, so that they did not get a drop on it. There was no difficulty in getting a wire now from 24 to 25 tons tensile, which would give ten twists in eight inches. With regard to span-wire construction, he agreed that this was the best system, but it was often very difficult to put up poles on both sides of the street on account of the pavements being full of pipes, and it was necessary to go in for side-wire construction. There was no trouble and no danger in putting up a long bracket arm. He had put them up, up to 22 ft. long. With regard to the anchoring of trolley wires, the great trouble in the span-wire construction was that, in anchoring the wire, they had to form a very ugly fork, which caught up the trolley head if the trolley left the wire. It might easily be arranged so that they could put up a double pull-off for taking the trolley wire over an extra span wire, and from that anchor in a vertical plane, so that if the trolley went off it went up in the air and missed the fork. The advantage was that if the trolley wire broke the ends of the wires were held up in position and did not drop down into the street, and the cars could be kept running. With regard to centre poles, from the traffic point of view centre poles were fatal for the proper running of a tramway. As to larger poles, the greatest difficulty in dealing with ordinary surveyors was that they all wanted to decrease the size of the poles. On the point of soldered and mechanical ears, his experience had been that soldered ears were a mistake, because they could never be quite sure that the ordinary wireman was going to use the proper temperature. With regard to Mr. McElroy's statistics, they were useful in themselves, and he suggested that Mr. Sayers, before the conference at the Tramways Exhibition in the summer with the Municipal Tramways Association, should get together similar information from all the companies, and they might discuss them, and have a sort of peace conference over a combined paper.

Mr. SAYERS in replying said that the question of the use of glass insulators in America and some continental countries, and their non-use here, was purely a question of climate. The glass surface had the peculiar property of condensing water from the damp atmosphere in a continuous film, and thus producing a considerable amount of leakage, whereas the glazed insulator condensed as much water, but in isolated drops, and did not leak nearly as much as glass, and that was the great reason why glass had not made way here. The question of the lightning arrester and the non-use of the horned pattern here, was another case of climatic difference. Mr. Lawson thought the standard poles too light, but he would point out that in the specification there was nothing to limit the thickness of the tubes. Of course it was perfectly easy to obtain larger outside diameters, but there was a great objection to increasing these dimensions. On the question of corrosion, that was an important point on which they had hardly enough experience to say much about at present. He had sections cut at the bottom of poles, which had been in use ten years, at the ground-line, and it did not appear that the internal corrosion was very rapid. It might be advisable to adopt some measure to prevent internal corrosion and give a greater life to the pole. One means of doing this would be to fill the pole up with weak Portland cement concrete, and it would also give the post additional stiffness. If the cost of moving telegraph and telephone wires, and gas and water pipes, and so on, was added to the cost of the overhead work, of course £1,200 or £1,000 for a single post line might not be sufficient. He was sorry he could not give information about bow trolleys. As regarded the galvanising of iron wire, the most important point in that process, as regards the wire itself, was the pickling. There was an objection to slackening the tension on trolley wires or span wires. There had been a good deal of experience about the desirability of tightly-stretched wire with telegraphic work, and telegraphic engineers always pulled their wires up as tightly as possible, having regard to the range of temperature. A tightly-strung system was, on the whole, steadier and less liable to disturbance by wind or blows, or any other disturbing element, than a slack system. It looked better, and there was a greater co-operation and natural support between the different members of the whole structure. In countries where hard and durable wood was abundant, and therefore cheap, he saw no reason why wooden poles should not have useful application. With regard to soldering, the hotter the bit the less heated the wire became, and less softening took place. The reason why wind and snow had to be regarded in respect of guard wires, but were comparatively insignificant with regard to trolley wires, was simply because the additional stress on a No. 8 wire when laden with snow, and blown upon by a hurricane, was a very much larger proportional addition to the suspended stress than in the case of the trolley wire. It was news to him, and he would be glad to see any statistics available showing that there were more accidents with No. o trolley wires than with thicker wires. It did not seem to him that this should be so, because the wire had a bigger margin of safety than the supporting structure. Mr. Fell's advice that he should collect statistics and information from the companies he would be very glad to take. He had already made a beginning, but some people did not keep the records they might, and some gentlemen did not like to give the records they had. However, he thought he would be able to overcome the reluctance in some cases.

A vote of thanks was awarded to Mr. Sayers for his paper.

TRAMWAY AND ELECTRIC RAILWAY LEGISLATION.

Some of the preliminary steps for the consideration of private bills have now been carried out at Westminster. Most of the bills relating to tramways and electric railways have been before the Examiners, and in a few cases non-compliance with the Parliamentary standing orders have been reported. The decision of the Standing Orders Committee on most of these measures has yet to come. The various bills have been apportioned between the two Houses, and have been read a first time.

SECOND READINGS.—In the House of Lords, February 21: Blackpool Improvement, Nottingham Corporation. February 24: Metropolitan District Railway. February 27: Gosport and Fareham Tramways, West Cumberland Electric Tramways (Extension of Time). March 2: Tyneside Tramways and Tramroads. March 3: Metropolitan and Great Central Railway Company's Southend and Colchester Light Railways, Mexborough and Swinton Tramways (Extension of Time), Oldham and Saddleworth District Tramways.

In the House of Commons, February 27: Aberdare Tramways, Accrington Corporation, Birmingham Corporation, Croydon Corporation, Halifax Corporation, Swansea Corporation. March 1: Great Western Railway (New Railways), Whitechapel and Bow Railway.

COVENTRY ELECTRIC TRAMWAYS.—On March 1, the Standing Orders Committee of the House of Commons reported that the promoters of this Bill had stated their intention of not proceeding with it. This was an extension of time bill.

LONDON COUNTY COUNCIL (TRAMWAYS).—In the House of Commons Sir Frederick Banbury and other members have given notice of a motion, to be proposed after the second reading of this bill, for the omission from the measure of the proposed tramways along the Victoria Embankment and across Blackfriars and Westminster Bridges.

WIGAN CORPORATION.—The Standing Orders Committee of the House of Commons, having considered the non-compliance with standing orders in connection with this bill, reported on March 1 that the bill should be allowed to proceed, provided the powers to construct tramway No. 2 be struck out, unless the consent of Aspull Urban District Council be proved before the Committee which will consider the bill.

MOTOR 'BUS PROPOSAL DEFEATED.—At a meeting of the South Shields Town Council on Wednesday, February 22, Alderman Readhead strongly urged the Council to defer the opening of the tenders for the construction of the electric tramway scheme until exhaustive inquiries had been made as to the working of the motor 'buses, and the advisability or otherwise of using them in preference to constructing electric tramways. The proposal was, however, defeated by ten votes to eight, and it was decided to proceed without delay to consider the tenders for the laying of the electric tramways.

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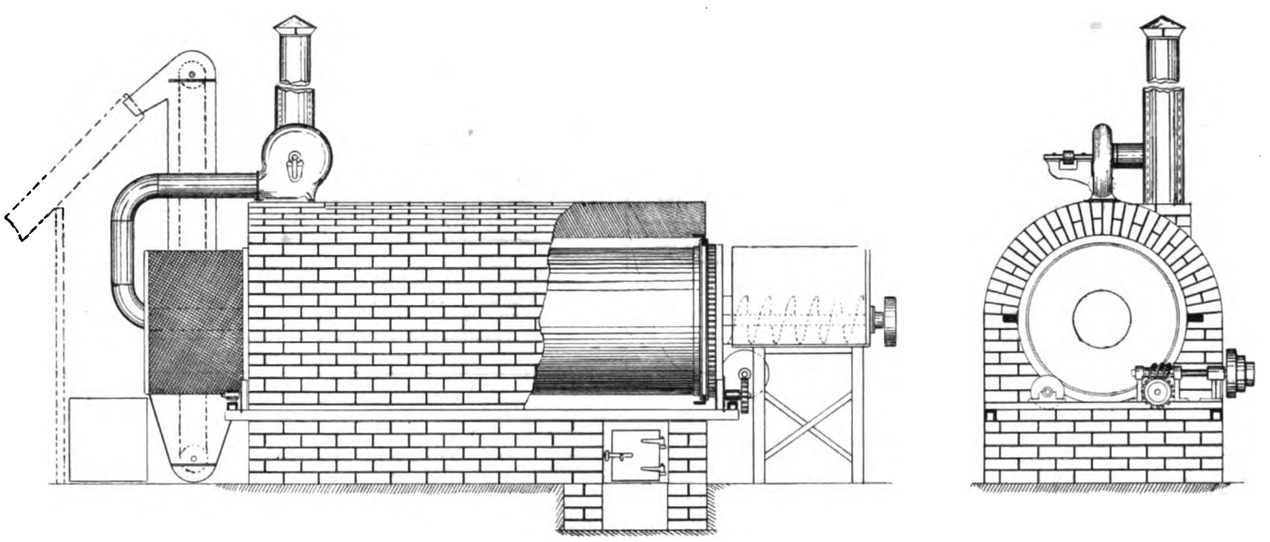
APPARATUS FOR DRYING SAND.

The apparatus illustrated below is a revolving cylinder, the wet sand being fed into it by means of a worm conveyor. The box in which the worm works can be made to hold from one to two tons and, if desired, this can be replenished by an elevator or any suitable traveller; other means of feeding can be adopted to suit circumstances.

The cylinder is made of strong steel plates, and it is fitted together in halves for ready access to the inside parts. The stove being at the feeding end, the wet sand prevents the plates from getting highly heated. The furnace can be arranged for burning either coke, producer gas, or liquid fuel. A means of heating which is nearly self-acting, easily regulated, quickly started, and turned off at pleasure, is a very obvious convenience for such work as this. Liquid fuel being now in plentiful supply, together with good appliances for using it, this should, in many cases, facilitate the adoption of this method of automatic drying.

The internal construction of this machine, however, is such that no very great amount of heat is required. Sand does not roll along the bottom in bulky masses, as is generally the case in cylinder drying. It is carried upwards and thinly distributed throughout the whole apparatus, thus making it practicable to dry at a very moderate heat; whilst the cylinder is so nearly balanced that a man with a handle could turn it at the required speed. Without going into a detailed description, some idea of the effect of these internal arrangements may be gathered when it is mentioned that with a revolving cylinder only 10 ft. long the sand must travel no less than 360 ft., in a thin stream, before it can reach the discharging end. If such a cylinder be rotated four turns a minute, the time taken in passing through will be exactly 20 minutes.



Three speeds are provided, and the feed can be regulated according to the condition of the sand.

A further economy of heat is effected by means of a jacket round the sheet-iron chimney, forming an annular space, down which the fan draws its air, heated by the hot chimney and free from smoke or fumes. Air thus heated is driven by the fan through the drying cylinder, carrying off the vapour and giving the good effects of wind drying upon sand. This fan only takes about ½ H.P. to drive.

At the discharging end is seen a screen, which revolves with the cylinder, the fine sand falling through, whilst the rough parts pass out at the extreme end. These separated products can, of course, be dealt with in any convenient way. They can fall into suitable boxes on wheels if preferred, or a simple elevator, as shown in the drawing, could pass the finished sand over a wall or bulk head without any handling at all. Hence the labour involved in the whole process is reduced to a minimum, and the same may be said of the space occupied by the apparatus. A cylinder 10 ft. long by 3 ft. in diameter would dry sand enough for all but a few of the largest tramway requirements. In many cases it would not be necessary to work such a cylinder more than one day a week. Nothing, therefore, would be lost by having an installation of much larger capacity than the daily consumption might demand.

It is well known, however, that the drying of sand in the usual pans, or hot plates, sifting, turning by hand, etc., etc, not only involves much very disagreeable work, but the sand thus treated is generally roasted, and its sharpness and utility greatly diminished, whilst sand dried with wind and a moderate temperature will go farther and be much more effective.

It is claimed, moreover, that this system of drying is of great interest not only for companies using electric traction, but also for the large railway companies who invariably dry their sand in pans placed over the lighting-up fires, the heat from which would otherwise be wasted. The cylinders here described can easily be erected over, or near to, such lighting-up furnaces, so as to carry a flue under the apparatus and thus give all the heat required. Hence the heat from these standing fires can be turned to good account as at present, together with the economy of an automatic process turning out a vastly improved product. At most locomotive depôts electric current is available, so that the small motive power for driving could readily be found.

All information respecting these appliances may be obtained from Mr. Edward Robinson, 133, Castelnau Road, Barnes, London, S.W., who is the inventor, and who supplies the apparatus.

MUNICIPAL TRAMWAY CONFERENCE IN LONDON.

A conference of representatives of twenty-nine local authorities in the United Kingdom owning and working tramways took place on Monday, February 13, at the Westminster Palace Hotel, London. The principal object of the Conference was to consider what action should be taken in regard to the application for power to run omnibuses contained in the Midland Railway Bill, the North Eastern Railway Bill, and the Great Western Railway Bill of the present session. Councillor D. Boyle, chairman of Manchester Tramways Committee, presided, and the conference adopted a resolution with a view of obtaining an amendment of the clauses so as to restrict the power of the railway companies to the conveyance of passengers to and from any of their railway stations. The conference had also under consideration a memorandum issued by the Tramways and Light Railways Association suggesting important alterations in the constitution of the Light Railway Commission. The memorandum included a suggestion that the Commissioners should be authorised to grant compulsory running powers over tramways and light railways. The conference expressed the opinion that the proposals were highly objectionable, and a communication was ordered to be sent to the Municipal Corporations Association in reference to the matter. The conference also had before them the draft of a bill which the Cyclists' Touring Club and the Automobile Association are promoting in the present session of Parliament with a view to compelling all vehicles to carry red lights at the rear at night. It was resolved that hearty support should be given to this bill.

The meeting was held in private, but we understand that the decision to oppose the application by the railway companies for powers to run motor omnibuses was strongly opposed. A number of those present recognised the futility and unwisdom of the course proposed, and had the municipal tramway departments of the country been fully represented it is probable that the proposal would have been negatived.

A second conference was held in London on Tuesday, February 28, of the Municipal Tramways Association for the purpose of considering proposals of several railway companies to establish motor omnibuses in connection with their railways. Councillor Boyle, Chairman of the Manchester Tramways Committee, presided, and about twenty authorities were represented. The conference framed a clause which provided for the limitation of the service of motor 'buses to routes between the companies' railway stations, and fixed points outside.

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ANALYSES OF TRAMWAY REPORTS.

DARWEN CORPORATION TRAMWAYS.

YEAR ENDING MARCH 31, 1904.

Electric traction inaugurated, October, 1900.

	£
Borrowing powers	93,400
Loans outstanding	72,250
Sinking Fund	7,296
Depreciation, Renewal, and Reserve Fund	3,000

CAPITAL EXPENDITURE.

	£	s.	d.
Permanent way, land, and buildings	33,390	8	6
Electrical equipment of line	10,087	13	1
Cars, etc.	9,593	15	4
Purchase price of Blackburn and Over-Darwen Tramway Company	26,200	0	4
Total	£79,271	17	3

Capital expenditure per mile of single track, £11,594.

REVENUE ACCOUNT.

INCOME.

	£	s.	d.	Av. per Car Mile d.
Traffic receipts	11,876	15	6	11·25
Advertisements	274	7	10	·26
Sundries	12	3	5	·01
	£12,163	6	9	11·52

EXPENDITURE.

Power Expenses.

	£	s.	d	d.	d.
Cost of electric energy	3,004	6	0		2·85

Traffic Expenses.

	£	s.	d.	£	s.	d.	d.	d.
Wages of motormen, conductors, and inspectors	2,160	9	8				2·05	
Cleaning and oiling cars	296	13	0				·28	
Cleaning, salting, and sanding track	119	0	4				·11	
Uniforms	79	1	10				·08	
Licenses	13	0	0				·01	
Fuel, power, light, and water for depôts and waiting rooms	67	17	6				·06	
Miscellaneous	15	18	8				·02	
				2,752	1	0		2·61

General Expenses.

Salaries and wages	306	19	8				·29	
Rents	64	4	8				·06	
Rates and taxes	292	15	2				·28	
Printing and stationery	113	8	1				·11	
Third party accident insurance	117	3	5				·11	
Light and water	70	7	11				·06	
Miscellaneous	9	17	4				·01	
				974	16	3		·92

Repairs.

Permanent way	264	1	9				·25	
Electrical equipment	344	6	1				·33	
Buildings	24	10	10				·02	
Cars, etc.	1,004	1	6				·95	
				1,637	0	2		1·55
Total				8,368	3	5		7·93
Balance carried to Net Revenue Account				3,795	3	4		3·59
				12,163	6	9		11·52

NET REVENUE ACCOUNT.

	£	s.	d.	£	s.	d.
Balance from Revenue Account				3,795	3	4
Amount received for excess of mileage by Darwen cars in Blackburn over Blackburn cars in Darwen				162	9	0
				£3,957	12	4
Deduct—						
Interest (net)	2,411	7	9			
Sinking Fund	1,981	19	1			
Depreciation	1,050	0	0			
				5,443	6	10
Deficit on year's working				£1,485	14	6

This loss is covered by guarantees to the amount of £350.

TRAFFIC STATISTICS.

Population served	39,000
Length of line operated (single track)	6 ms. 67 ch.
Passengers carried	2,236,082
Car mileage	253,345
Passengers carried per car mile	8·83
Average fare per passenger	1·27d.
Operating expenses per passenger	·90d.
Percentage of operating expenses to total receipts	68·80
Board of Trade units	412,000
Cost of Board of Trade unit	1⅜d.
Board of Trade unit per car mile	1·63

DUNDEE CORPORATION TRAMWAYS.

YEAR ENDING MAY 15, 1904.

Electric traction inaugurated July, 1900.

	£
Loans outstanding	220,410
Sinking Fund	32,183
Reserve Fund, etc.	9,208

CAPITAL EXPENDITURE.

	£	s.	d.
Permanent way	185,013	18	4
Buildings	18,113	17	0
Cars	37,006	9	7
Machinery and plant	1,011	2	5
Parliamentary expenses	10,933	18	2
Purchase of Tramway Company's undertaking	8,446	17	9
Miscellaneous	2,855	12	9
Total	£263,381	16	0

Capital expenditure per mile of single track, £11,334.

REVENUE ACCOUNT.

INCOME.

	£	s.	d.	Av. per Car Mile d.
Traffic revenue	43,816	0	11	11·15
Other revenue	621	2	6	·16
	£44,437	3	5	11·31

EXPENDITURE.

Power Expenses.

	£	s.	d.	d.	d.
Cost of power	10,344	1	8		2·63

Traffic Expenses.

	£	s.	d.	£	s.	d.	d.	d.
Wages of Motormen, conductors, inspectors, etc.	10,021	9	1				2·55	
Cleaning and oiling cars	251	5	9				·06	
Salting and sanding track	40	4	6				·01	
Fuel, light, and water	469	15	11				·12	
Tickets	128	13	4				·03	
Uniforms	433	8	10				·11	
Licenses	54	0	0				·02	
Miscellaneous	8	7	3				·002	
				11,407	4	8		2·90

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General Expenses.

	£ s. d.	£ s. d.		
Salaries .. .	590 0 0		·15	
Rents and feu duties ..	295 0 7		·07	
Rates and taxes	971 13 5		·25	
Fire insurances .. .	83 15 0		·02	
Auditor's fee	40 0 0		·01	
Printing, stationery, and advertising	181 12 4		·05	
Fuel, cartage, carriages, etc.	143 10 4		·04	
Miscellaneous	103 7 2		·03	
		2,408 18 10		·62

Repairs.

	£ s. d.	£ s. d.		
Permanent way	1,350 14 6		·34	
Cars, buildings, and machinery	2,430 12 11		·62	
		3,781 7 5		·96
Total		27,941 12 7		7·11
Balance carried to Net Revenue Account		16,495 10 10		4·20
		£44,437 3 5		11·31

NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account ..		16,495 10 10
Deduct—		
Interest	6,836 17 5	
Sinking Fund	5,000 0 0	
Income tax	479 5 4	
Depreciation, renewal, and reserve	2,942 8 10	
		15,258 11 7
Balance applied to wipe off deficiency on previous year's working		£1,236 19 3

TRAFFIC STATISTICS.

Population served	163,000
Length of line operated (single)	23 m. 19 chs.
Passengers carried	11,420,985
Car mileage	942,969
Passengers carried per car mile	12·11
Average fare per passenger	·92d.
Operating expenses per passenger	·59d.
Percentage of operating expenses to total receipts.. ..	62·88
Board of Trade units	1,661,721
Cost per Board of Trade unit	1½d.
Board of Trade units per car mile	1·76

ILFORD URBAN DISTRICT TRAMWAYS.

YEAR ENDING MARCH 31, 1904.

Electric traction inaugurated, March, 1903.

	£ s. d.
Loans outstanding	115,011 19 6
Sinking Fund	2,291 0 6

CAPITAL EXPENDITURE.

	£ s. d.
Permanent way	80,392 3 10
Electrical equipment	15,234 19 3
Buildings and fixtures	12,041 13 3
Power-station plant	10,441 10 11
Cars	11,769 6 9
Workshop, tools, and sundry plant	1,152 3 7
Miscellaneous	1,842 6 4
Total	£132,874 3 11

Capital expenditure per mile of single track, £12,655.

REVENUE ACCOUNT.

INCOME.

	£ s. d.	Av. per Car Mile d.
Traffic revenue	22,587 17 1	9·39
Other revenue	630 0 8	·26
	£23,217 17 9	9·65

EXPENDITURE.

Power Expenses.

	£ s. d.	d.	d.
Cost of electricity	3,701 9 2		1·54

Traffic Expenses.

	£ s. d.	£ s. d.		
Wages	5,100 0 5		2·12	
Cleaning and oiling cars	802 13 10		·33	
Cleaning, salting, and sanding track	109 19 5		·05	
Fuel, power, light, and water for depôts, etc...	193 15 9		·08	
Ticket check	863 2 4		·36	
Uniforms	141 15 9		·06	
Miscellaneous	82 15 5		·03	
		7,294 2 11		3·03

General Expenses.

	£ s. d.	£ s. d.		
Salaries	388 18 9		·16	
Rents	6 0 0		—	
Rates and taxes	288 18 9		·12	
Printing, stationery, and advertising	144 12 9		·06	
Fuel and light for offices	9 9 0		—	
Law charges	4 6 6		—	
Insurance	402 8 6		·17	
Sundries	155 3 11		·07	
		1,399 18 2		·58

Repairs.

	£ s. d.	£ s. d.		
Permanent way	104 9 1		·05	
Electrical equipment ..	1 7 3		—	
Buildings	9 14 11		—	
Tools and implements ..	53 10 1		·02	
Cars	1,003 9 8		·42	
		1,172 11 0		·49
Total		13,568 1 3		5·64
Balance carried to Net Revenue Account		9,649 16 6		4·01
		23,217 17 9		9·65

NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account ..		9,649 16 6
Deduct—		
Interest	3,345 4 4	
Sinking Fund	2,291 0 6	
		5,636 4 10
Balance carried forward		£4,013 11 8

TRAFFIC STATISTICS.

Population served	52,000
Length of line operated (single)	10 mls. 40 chs.
Passengers carried	5,274,025
Car mileage	577,034
Passengers carried per car mile	9·14
Average fare per passenger	1·02d.
Operating expenses per passenger	·62d.
Percentage of operating expenses to total receipts ..	58·44
Board of Trade units	585,041
Cost per Board of Trade unit	1·52d.
Board of Trade units per car mile	·99

PORTSMOUTH CORPORATION TRAMWAYS.

YEAR ENDING MARCH 31, 1904.

Electric traction inaugurated September, 1901.

	£ s. d.
Borrowing powers	564,250 2 3
Loans outstanding	587,861 17 6
Sinking Fund	46,543 16 6
Reserve Fund	22,993 10 7

CAPITAL EXPENDITURE.

	£ s. d.
Purchase of undertaking	205,964 18 1
Permanent way and electrical equipment	254,261 6 3
Buildings	38,527 10 0
Power-station plant..	35,768 7 10
Workshop tools and sundry plant	476 16 5
Cars	49,551 7 6
Printing, stationery, and advertising	557 17 4
Parliamentary expenses	4,311 16 2
Cost of issue of Redeemable Stock	44,226 13 2
Sundry expenses	759 1 3
Total	£634,405 14 0

Capital expenditure per mile of single track, £22,260.

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REVENUE ACCOUNT.

INCOME.

	£ s. d.	Av. per Car Mile d.
Traffic revenue	88,523 10 6	11·62
Other revenue	5,650 10 2	·74
	£94,174 0 8	12·36

EXPENDITURE.

Power Expenses.

	£ s. d.	d.	d.
Power expenses	6,096 9 5		·80

Traffic Expenses.

Superintendence.. ..	577 12 0	·08	
Wages	16,397 17 1	2·15	
Cleaning and oiling cars	2,107 8 4	·28	
Cleaning track, etc. ..	1,749 8 2	·23	
Light and water	69 4 2	·009	
Ticket check	2,096 3 11	·27	
Uniforms	496 19 0	·07	
Miscellaneous	282 17 3	·04	
	23,777 9 11		3·12

General Expenses.

Salaries and wages ..	982 1 10	·13	
Rents	233 8 10	·03	
Rates and taxes	5,353 0 11	·70	
Printing, stationery, and advertising	332 7 3	·04	
Law charges	17 18 6	·002	
Insurances and compensation	415 9 8	·06	
Miscellaneous	966 11 1	·13	
	8,300 18 1		1·09

Repairs.

Permanent way	654 2 3	·09	
Power-station plant ..	165 14 3	·02	
Buildings	89 15 9	·01	
Cars	3,816 19 11	·50	
Electrical equipment of line	525 4 9	·07	
	5,251 16 11		·69
Total	43,426 14 4		5·70
Balance carried to Net Revenue Account	50,747 6 4		6·66
	£94,174 0 8		12·36

NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account ..		50,747 6 4
Deduct—		
Interest	18,342 12 6	
Sinking Fund	15,119 0 2	
Tolls paid to Portsdown, etc., Light Railway	1,257 2 3	
		34,718 14 11
Balance to Reserve Fund		£16,028 11 5

TRAFFIC STATISTICS.

Population served	200,000
Length of line operated (single)	28½ miles
Passengers carried	18,204,426
Car mileage	1,828,193
Passengers carried per car mile	9·95
Average fare per passenger	1·17d.
Operating expenses per passenger	·57d.
Percentage of operating expenses to total receipts ..	46·11
Board of trade units (traction)	1,788,300
Cost of Board of Trade unit	·55d.
Board of Trade units per car mile	·98

SALFORD CORPORATION TRAMWAYS.

YEAR ENDING MARCH 31, 1904.

Electric traction inaugurated October, 1901.

	£ s. d.
Borrowing powers	1,114,205 0 0
Loans outstanding	531,466 13 11
Sinking Fund	70,185 10 1
Depreciation, renewal, and reserve	12,202 10 4

CAPITAL EXPENDITURE.

	£
Capital expenditure	620,069

Capital expenditure per mile of single track, £10,421.

REVENUE ACCOUNT.

INCOME.

	£ s. d.	Av. per Car Mile d.
Traffic revenue..	198,584 5 7	10·08

EXPENDITURE.

Power Expenses.

	£ s. d.	d.	d.
Electric currrent	47,986 10 2		2·43

Traffic Expenses.

	£ s. d.		
Superintendence ..	200 0 0	·01	
Wages (motormen, conductors, etc.)	40,294 10 10	2·05	
Cleaning and oiling cars	8,882 2 3	·45	
Cleaning & sanding track	929 6 0	·05	
Fuel, power, light, and water for depôts ..	495 7 1	·02	
Ticket check	2,368 17 2	·12	
Uniforms	1,900 5 6	·10	
Miscellaneous	253 8 3	·01	
	55,323 17 1		2·81

General Expenses.

Salaries	1,722 11 2	·09	
Proportion of salaries of treasurer's department	600 0 0	·03	
Rents, rates, etc. ..	6,282 12 3	·32	
Printing, stationery, and advertising	1,115 2 0	·06	
Fuel, light, and water for offices	216 18 6	·01	
Law charges	104 3 0	·005	
Accident insurances and compensations.. ..	4,523 5 10	·23	
Fire and other insurances	124 14 8	·006	
Miscellaneous	893 18 10	·05	
	15,583 6 3		·80

Repairs.

Permanent way	4,048 3 7	·20	
Electrical equipment of line	3,620 7 0	·19	
Buildings	409 1 6	·02	
Cars	9,455 16 7	·48	
	17,533 8 8		·89
Total	136,427 2 2		6·93
Balance carried to Net Revenue Account	62,157 3 5		3·15
	£198,584 5 7		10·08

NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account ..		62,157 3 5
Deduct—		
Interest	16,491 1 10	
Sinking Fund	16,171 1 2	
Income tax	966 16 11	
Rents of lines	10,903 4 5	
Hire of cars	2,185 0 0	
Depreciation and renewal	3,439 19 1	
		50,157 3 5
Handed over to relief of rates		£12,000 0 0

TRAFFIC STATISTICS.

Population served	300,000
Length of line operated (single)	59½ miles
Passengers carried	36,956,405
Car mileage	4,726,446
Passengers carried per car mile	7·82
Average fare per passenger	1·29d.
Operating expenses per passenger	·89d.
Percentage of operating expenses to total receipts ..	68·70
Board of Trade units	6,102,524
Cost of Board of Trade unit	1·89d.
Board of Trade units per car mile	1·29

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SHEFFIELD CORPORATION TRAMWAYS.

FOR YEAR TO MARCH 25, 1904.

System taken over by Corporation.

Electric traction inaugurated, September, 1899.

	£	s.	d.
Borrowing powers			
Loan debt outstanding	1,045,430	16	2
Sinking Fund and repayment of debt..	112.297	17	0
Renewals Fund	50,000	0	0
Contingencies Fund	5,125	17	2
Revenue accumulations	43,705	2	11

CAPITAL EXPENDITURE.

	£	s.	d.	£	s.	d.
Horse traction (original construction)				44,296	1	10
Horse traction (purchase)				8,891	5	11
Horse traction (additional equipment)				1,694	18	4
Electric traction (do.)				4,804	14	6
Tramway Act, 1897:						
Construction and reconstruction ..	400,005	18	5			
Electrical equipment	179,087	6	3			
Power station	73,700	0	0			
				652,793	4	8
Tramways Act, 1900:						
Construction	39,065	15	5			
Electrical equipment	81,375	9	9			
Power station	52,828	1	7			
Car shed	36,784	2	0			
"	25,661	2	6			
				235,714	11	3
Tramways Act, 1901:						
Doubling lines				749	13	8
Suspense Account and miscellaneous accounts	30,374	19	7			
Purchase of land..	8,996	10	11			
				39,371	10	6
Total				£988,316	0	8

Capital expenditure per mile of single track, £

REVENUE ACCOUNT.

INCOME.

	£	s.	d.	Av. per Car Mile d.
Traffic receipts	232,351	9	11	9·667
Advertising	912	7	2	·038
Miscellaneous	2,717	18	0	·113
	£235,981	15	1	9·818

EXPENDITURE.

Power Expenses.

	£	s.	d.	£	s.	d.	d.	d.
Salaries	860	9	6				·036	
Wages	6,294	3	9				·262	
Coal and coke	8,182	0	6				·340	
Water	934	12	10				·039	
Oil, waste, and supplies	605	7	2				·025	
Plant, tools, fittings and repairs	1,251	19	4				·052	
				18,128	13	1		·754

Traffic Expenses.

	£	s.	d.	£	s.	d.	d.	d.
Salaries	729	6	6				·030	
Wages of motormen ..	53,575	13	8				2·230	
Wages of inspectors and conductors	28,887	13	8				1·210	
Wages of cashiers ..	1,686	12	8				·070	
Oiling and cleaning cars	662	10	9				·030	
Cleaning, salting, and sanding track	1,404	6	6				·060	
Fuel, light, and water for depôts	1,185	16	10				·050	
Ticket check	1,784	0	10				·070	
Licenses	259	14	6				·010	
Uniform	1,750	1	7				·070	
Miscellaneous	1,538	5	3				·060	
				93,464	2	9		3·890

General Expenses.

	£	s.	d.	£	s.	d.	d.	d.
Salaries and wages ..	1,602	1	4				·066	
City treasurer and auditor	271	0	0				·011	
Town Hall expenses ..	100	0	0				·004	
Rents	695	5	5				·029	
Rates	6,993	11	2				·291	
Property and Income Tax	1,095	17	1				.046	
Printing, stationery, and advertising	633	7	5				·026	
Third party insurances and compensation ..	2,366	16	10				·098	
Employers' liability insurance	410	10	0				·017	
Fire insurance	556	2	7				·024	
Law expenses	57	19	0				·002	
Travelling and deputation expenses	131	9	10				·005	
Management of stock, etc.	437	2	7				·018	
Miscellaneous	1,078	17	8				·046	
				16,430	0	11		·683

Repairs.

	£	s.	d.	£	s.	d.	d.	d.
Permanent way	8,511	12	3				·354	
Electric equipment of line	5,789	3	3				·241	
Cars	12,782	19	10				·532	
Buildings	1,142	16	8				·047	
Machinery, tools, &c. ..	27	15	5				·001	
				28,254	7	5		1·175
Total				156,277	4	2		6·502
Balance carried to Net Revenue Account				79,704	10	11		3·316
				235,981	15	1		9·818

NET REVENUE ACCOUNT.

	£	s.	d.	£	s.	d.
Balance from Revenue Account ..				79,704	10	11
Deduct—						
Interest	32,874	19	3			
Sinking Fund	19,394	4	9			
Depreciation	125	13	6			
				52,394	17	6
				£27,309	13	5
Which has been appropriated as under:						
Deficiency in District Rate ..	10,467	10	8			
Grant to School of Modern Languages	100	0	0			
Grant towards Music in Parks ..	200	0	0			
Renewals Fund	16,542	2	9			
				27,309	13	5

TRAFFIC STATISTICS.

Population	432,940
Length of line	31¾ miles
Passengers	61,450,993
Car mileage	5,768,231
Passengers carried per car mile	10·65
Average fare per passenger	·907d.
Operating expenses per passenger	·61d.
Percentage of operating expenses to receipts	66·27

TRAMWAY SOCIETIES.

WEST HAM CORPORATION.

The first annual meeting of the club was held at the West Ham Lane Car Depôt on February 10, Mr. H. E. Blain, tramways manager, presiding. The report submitted by the hon. secretary, Mr. G. E. Broom, showed that the club had been very successful, and the hon. treasurer's statement, submitted by Mr. T. Somerville, showed a balance in hand of over £11. Both the cricket and the football clubs have made a creditable beginning and anticipate a successful year. The manager was re-elected president, and a representative committee was appointed for the general management of the club, with separate committees for the departmental clubs.

HULL TRAMWAY ENGINEERS.

The recreation club in connection with the electrical engineers' department of the Hull City Tramways, held their first smoking concert at the Manchester Hotel, on February 17. Mr. J. Wilkinson, M.I.E.E., was in the chair. In a few well-chosen remarks, the chairman said that the future of the tramways in Hull was very bright, and when the proposed extensions were finished, would be the means of giving employment to many men. The toast of "The Mayor" (Ald. F. Larard), who is president of the club and chairman of the Tramways Committee, was responded to with musical honours. From the attendance, which numbered about 250, there is apparently a successful future for this club.

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MUNICIPAL TRAMWAY ASSOCIATION.

MANAGERS' SECTION AT BIRMINGHAM.

The managers' section of the Municipal Tramway Association met in Birmingham on February 24 and 25. Among those present were the following:

J. Aldworth, general manager, Nottingham; A. Baker, general manager, Birmingham; W. Binns, general manager, Reading; H. E. Blain, general manager, West Ham; A. Coveney, general manager, Ashton-under-Lyne; W. Clough, general manager, Bury; Jas. Dalrymple, general manager, Glasgow; A. Ellis, general manager, Cardiff; E. Edwards, general manager, Gloucester; C. R. Everson, general manager, Plymouth; A. R. Fearnley, general manager, Sheffield; A. L. C. Fell, chief officer, London County Council tramways; W. A. Fraser, general manager, Nelson; R. R. Greene, general manager, Wallasey; J. Gottschalk, general manager, Northampton; W. Grant, general manager, Rotherham; J. B. Hamilton, general manager, Leeds; E. Hatton, general manager, Salford; R. L. Horsfield, general manager, Walsall; T. J. Kendrew, Southport; J. Lancaster, general manager, Blackpool; W. A. Luntley, general manager, Wolverhampton; J. M. McElroy, general manager, Manchester; J. S. D. Moffett, general manager, Rochdale; H. Mozley, general manager, Burnley; P. J. Pringle, general manager, Burton-on-Trent; L. Slattery, general manager, Oldham; C. J. Spencer, general manager, Bradford; W. H. Tittensor, general manager, Preston; and W. Wyld, general manager, Birkenhead.

The members met at the Council Hall, and were received by Mr. Alderman Beale, Chairman of the Birmingham Tramways Committee. Mr. Alderman Beale, in welcoming the company, as chairman of the tramway committee, said that he took some credit for the holding of the meeting in Birmingham, because they had at the head of their tramway undertaking a gentleman who stood high among tramway experts. He did not flatter himself that the conference had come to Birmingham to see a model tramway system, although they might be able to view a collection of "old masters"; their engines, however, would not be on exhibition very long. They were gradually disappearing, and a number were only just removed. Most of those present had gone through the transition period, and they knew the difficulties associated with the removal of an antiquated system. Committees were obliged to rely on the tramway expert, especially in regard to the problem of restrictions by the Board of Trade. They had very little opportunity of putting pressure on the authorities to lighten the burden, and they must, therefore, have guidance from those who were in a position to speak with authority, and say that certain things should not be submitted to without some sort of protest. The great argument for municipalists must be that the public had better access to a town council than to a private company to get what they wanted. In Birmingham they had been able to settle that, because they had put the convenience of the public first, and the authorities had approached the matter in a temperate spirit. Their local authorities had a receptive mind, and the municipality would be certain to benefit by the conference.

Mr. J. B. Hamilton (Leeds), responding, complimented Birmingham on the courage with which they had set themselves to provide through communication.

The meeting was held in private afterwards. The following programme was discussed.

"Overhead Equipment—Notes on its construction and maintenance," introduced by Mr. J. M. McElroy.

"Tramway Telephones," introduced by the President.

At 1 p.m. the members adjourned to the Grand Hotel for luncheon, and subsequently they inspected the power-house of the City of Birmingham Tramways Company at Yardley, where "Diesel" oil engines are in operation. They also inspected about 30 cars which the Company have recently obtained, and which are equipped with Raworth's regenerative-control system. On February 25 the following subjects were submitted for discussion.

"Local Taxation of Tramways," introduced by Mr. F. Coutts.

"Collection and Delivery of Parcels in connection with Tramway Systems," introduced by Mr. C. J. Spencer.

"Universal Indicators for Tramway Stopping Stations," introduced by Mr. A. R. Fearnley.

A meeting of the executive committee took place at the conclusion of the discussion, when several topics of interest were considered.

MOTOR COACHES ON THE NORTH STAFFORDSHIRE RAILWAY.—At the general meeting of the North Staffordshire Railway Company, the chairman attributed the falling-off of 175,000 in passengers carried to poverty in the district, to the lack of football matches, and to the effect of tramway competition. In order to fight tramway competition, he announced that the company had ordered two motor-coaches as an experiment to run on rails, stopping at places other than regular stations, and picking up passengers *en route* at level crossings, bridges, etc. These motor-coaches would run through the populous districts.

LIGHT RAILWAY COMMISSION.

On February 6 the Light Railway Commissioners issued their decision respecting the Maidstone Corporation Light Railways (Extensions) Order. The effect of the decision is that the lines applied for will be granted except Railway (No. 3) in Holland Street and both the lines on either side of the prison. The Order to be submitted to the Board of Trade will authorise one of such lines as proposed on whichever side of the prison the Corporation may prefer. The Commissioners also stated that they would have felt considerable doubt as to the advisability of authorising light railways in such narrow streets as Week Street and Stone Street in any case where the support given to the proposals had not been so strongly expressed on behalf of the local authority and, with but few exceptions, of the residents in those streets.

The Commissioners sat at Grimsby on Monday, February 6, to consider the application of the Great Central Railway Company for an Order to authorise the Grimsby District Light Railway, and decided to grant the application up to the eastern limit of the proposed new dock at Immingham.

On February 7 the Commissioners considered and granted the application for the Axholme Joint Railway (Hatfield Moor Extension). On the same day the Commissioners approved the application for the Blyton and Frodingham Light Railway.

The Commissioners sat at Newark on February 8, and approved the application for the proposed Newark and District Light Railway with the exception of Railway No. 6.

The draft of the Devonport Light Railway Order, authorising the construction of a light railway in the county borough of Devonport, was issued on February 8.

On February 13 the Light Railway Commissioners submitted the following Orders to the Board of Trade for confirmation:

> The Portmadoc, Beddgelert, and South Snowdon Railway (Beddgelert Light Railway Extension) Order, 1905, authorising the construction of a light railway in the county of Carnarvon (being an extension of the existing and authorised undertaking of the Portmadoc, Beddgelert, and South Snowdon Railway Company), and the transfer to that Company of the powers conferred upon the North Wales Narrow Gauge Railways Company by the North Wales Narrow Gauge Railways (Beddgelert Light Railway Extension) Order, 1900, and other matters.
>
> The North Wales Narrow Gauge Railways (Light Railway) Order, 1905, authorising the working and maintenance of the Moel Tryfan undertaking of the North Wales Narrow Gauge Railways Company as a light railway, and other matters.

The Commissioners sat at Bath on Wednesday, February 15, to consider the application for an Order to authorise the Bath Electric Tramways (Light Railway Extensions.) The Commissioners granted the application, with the exception of the line in Westgate Street.

The Board of Trade have confirmed the following Order made by the Light Railway Commissioners:

> Hope, Bradwell, and Castleton Light Railway Order, 1905, authorising the construction of a light railway in the county of Derby, from the Midland Railway Company's (Dore and Chinley) railway at or near Hope Station to Bradwell and Castleton.

The Commissioners have fixed local inquiries respecting the following applications:

> Knutsford and Warrington Light Railway, at Warrington, on March 14.
>
> Tarporley and Mouldsworth Light Railway, at Tarporley, on March 15.
>
> Headcorn and Maidstone Junction Light Railway, at Maidstone, on March 17.
>
> Mansfield and District Light Railway (Extensions), at Mansfield, on March 20.
>
> Ackworth and Lindsey Light Railway, at Barton-on-Humber, on March 21; and at Pontefract, on March 22.
>
> Bideford, Clovelly, and Hartland Light Railway, at Bideford, on March 29.

On February 17 the Commissioners submitted to the Board of Trade, for confirmation, the Welshpool and Llanfair Light Railway (further borrowing powers) Order, 1905, amending the Welshpool and Llanfair Light Railway (Amendment) Order, 1901, and for other purposes.

On February 20 the Commissioners submitted to the Board of Trade, for confirmation, the County of Middlesex Light Railways (extension of time) Order, 1905, amending the County of Middlesex Light Railways Order, 1901.

On February 23 the Commissioners issued a notice stating that objections to the application made in November, 1904, for the Portmadoc, Beddgelert, and South Snowdon Railway (Light Railway) Order should be sent in on or before March 11; and that the Commissioners do not propose to hold a further local inquiry as to the present proposals unless, upon consideration of such objections, that course should appear to them to be desirable.

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PERSONAL.

Mr. J. C. Couper, traffic superintendent of the Newcastle Corporation Tramways, has resigned.

Mr. Robert Morrison has been appointed goods manager of the Midland Great Western Railway of Ireland.

Mr. Thomas Elliott has been appointed superintendent of the line of the Midland Great Western Railway of Ireland.

Mr. Robert Blackmore, resident engineer of the Stalybridge Joint Tramways, has had his salary increased from £350 per annum to £450.

Mr. Thos. Browett, M.I.M.E., M.I.E.E., has been appointed manager of the Diesel Engine Company, Limited, 179, Queen Victoria Street, E.C.

Mr. F. Schofield, commercial manager of the Stalybridge, Mossley, Dukinfield, and Hyde Joint Tramways, has been granted an increase of salary from £250 to £350 per annum.

Mr. James Buckley, chief assistant to Mr. Robert B. Holt, permanent way engineer to the Leeds City Tramways, has been granted an increase in salary to £200 per annum.

Mr. Harison Jones, late of the consulting engineering firm of Messrs. Rotter and Jones, sailed recently by mail boat for Monte Video, where he will take up the position of engineer to the Monte Video Tramways.

Mr. W. Ralph, of the Stalybridge, Hyde, Mossley and Dukinfield Tramways, has been appointed by the Leith Tramways Reconstruction Sub-Committee to superintend the reconstruction of the tramway system in that town.

Mr. Arthur Churchill, of the British Thomson-Houston Company, delivered a lecture on "Edison and his Early Work," before the Rugby Engineering Society on Thursday evening, February 16, at the Benn Building, Rugby.

Mr. F. Gill, senior clerk to the Huddersfield Corporation Tramways, is retiring after 21 years' service. On February 17 he was presented by the tramway employees with a gold curb albert with engraved medal as a mark of their esteem.

Mr. C. T. Yerkes, chairman of the Underground Electric Railways Company of London, has been elected chairman of the Metropolitan District Railway Company; Mr. R. W. Perks, who has been chairman for two years, during which time the price of the shares has steadily risen from 17 to 42, retiring in his favour and becoming vice-chairman.

Mr. Frederick Coutts, general manager of the Ayr Corporation Tramways, has been appointed manager of the Paisley Tramways at a commencing salary of £400 per annum. Mr. Coutts came to Ayr from Dundee when the tramways were inaugurated in 1901, and his management of the system has been conspicuously successful.

Manchester Corporation Tramway Officials.—The Tramways Committee recently recommended the following increases of salary: Mr. J. J. McMahon, electrical engineer, from £300 to £350 per annum; Mr. H. Mattinson, permanent way engineer, from £250 to £275; and Mr. F. Broughton, assistant electrical engineer, from £200 to £225 a year.

Newcastle Tramways Committee on February 23 received the report of a sub-committee on the candidates for the position of tramways manager. It was reported that Mr. Conaty, of Birmingham, had withdrawn his candidature. In order that there should be more than two names to go before the Council, it was agreed to ask Mr. Spencer, of Bradford, to allow his name to go forward to the Council. At a meeting of the Town Council on March 1, Mr. Ernest Hatton, manager of Salford Corporation Tramways, was by a majority of 40 votes against 9 appointed manager.

Mr. L. S. Smart, the manager of the locomotive works at Brighton of the London, Brighton, and South Coast Railway Company, has been appointed chief locomotive superintendent of the Central South African Railways (Transvaal and Orange River Colony). For the post, the salary of which is £1,200 per annum, with a personal annual allowance of £400, applications were invited by the Crown Agents for the Colonies from locomotive engineers employed on all British railway systems.

Mr. Thomas Edward Bryers, the vice-chairman of the Sunderland Corporation Tramways Committee, was found lying dead by the side of the River Ure at the Lower Falls at Aysgarth recently. At the inquest it transpired that the deceased gentleman had been suffering from sleeplessness and overwork, and he had complained that he was almost demented with pain. Mr. Bryers had evidently fallen from a rock about 40 ft. high. The jury returned an open verdict, and expressed sympathy with the widow and family of deceased.

Mr. T. B. Holliday, engineer and manager of the Brighton Corporation Tramways, has resigned in order to take up a similar appointment with the Hastings and District Tramways Company. Prior to his appointment to the managership of the Brighton Corporation Tramways in 1900, Mr. Holliday held a responsible position in the service of the Imperial Tramways Company, and supervised the laying of their tracks in London, Bristol, Stockton-on-Tees, Middlesbrough, and other towns. He was previously for eleven years with the Melbourne Cable Tramways Company.

Mr. William Grant, manager of the Rotherham Corporation Tramways, has been appointed manager of the Ayr Corporation Tramways, in succession to Mr. Frederick Coutts. Mr. Grant has had 12 years' experience in tramway work with the Corporations of Blackpool, Darwen, and Rotherham. The Ayr Town Council received 83 applications for the post, and a final selection was made from Mr. C. Clark, of Birkenhead Corporation Tramways; Mr. J. C. Cooper, traffic superintendent, Newcastle Corporation Tramways; and Mr. Grant.

Bradford City Council and their Tramway Manager.—On Tuesday, February 14, in the Bradford City Council, Mr. J. W. Swithenbank moved a resolution to the effect that as Mr. C. J. Spencer, the manager of the Bradford tramways, had applied for the post of manager of the Newcastle Corporation tramways, he was dissatisfied with his post in Bradford, and should therefore be asked to resign. A long and acrimonious discussion took place, the chief features of which were an admission of Mr. Spencer's general ability, and some differences of opinion arising out of a claim made by the Chairman of the Tramways Committee that there should be no appeal from the manager on points of discipline. The resolution was defeated by 31 votes to 16.

Obituary.—We regret to record the death of Mr. Archibald Grierson, for about 20 years the secretary of the London Road Car Company, prior to joining which he was associated with the Edinburgh Street Tramways.

CONTRACTS AND ORDERS.

Stepney Borough Council have placed an order with Messrs. C. A. Parsons and Company for a steam turbine generator, at £5,900.

Messrs. Cowans have received an order for a switchboard at £106 10s. from Gravesend Corporation.

Stockport Corporation have accepted the tender of R. W. Blackwell and Company, Limited, for the overhead equipment of the Hazel Grove tramways at £4,343.

Swindon Corporation have accepted the tender of Messrs. J. J. Horsfield, of Dewsbury, for a Lancashire boiler for the electricity works at £1,385.

Hadfield's Steel Foundry Company, Limited, have the contract for the special track work at the Sandy Row tramway depôt, Belfast, at £1,126.

The British Insulated and Helsby Cables, Limited, have secured the contract for the supply of cables for the Stockport Corporation Tramways at £223 15s.

Messrs. G. C. Milnes, Voss and Company have the contract for supplying four tramcar top-covers for Warrington Corporation Tramways at £80 each, inclusive of new trolley poles.

The British Thomson-Houston Company, Limited, have received an order from Rochdale Corporation for the supply of a high-tension switchboard for the electricity works.

Dublin United Tramways Company have placed an order with Davis-Perrett, Limited, for one of their electrical grease-separating plants, capable of purifying 4,000 gallons of greasy water per hour.

East Ham Council have accepted the tender of Messrs. Meldrum Bros. for the supply and erection of two ranges of destructor cells and regenerator, at £3,105.

Bolckow, Vaughan and Company, Limited, of Middlesbrough, have received an order for 400 tons of steel girder rails and 20 tons of fishplates for the Bradford Corporation Tramways.

Messrs. Yates and Thom, of Blackburn, have secured the Leicester Town Council's contract for the supply of two boilers and boiler-house appliances for the tramways main power-station, at £6,062.

Belfast Tramways Committee have accepted the tender of Loughlin and Harvey, a local firm, for the erection of the generating station, at £19,690.

Leicester Corporation have accepted the tender of the British Westinghouse Company, Limited, for the supply of two tramcars at £575 each.

Messrs. J. and B. Pearse and Company, of 28, Floral Street, W.C., have received the contract for the supply of uniforms for the Gloucester Corporation Tramway employees.

M. P. Galloway, Limited, of Leith, have received the contract from the Leith Tramways Reconstruction Sub-Committee for the supply of centre-poles and accessories at £4,471.

Fulham Borough Council have accepted the tender of the Universal Engineering Company, Limited, for the construction of a brick chimney shaft at the electricity works at £2,157 10s.

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Derby Tramways Committee have accepted the tender of Callender's Cable Company, Limited, amounting to £208 10s., for feeder cables in connection with the extension of the Corporation tramways.

Pearson, Huggins and Company, Limited, of 51, Scrutton Street, London, E.C., have secured for the third year in succession the contract for the supply of uniforms for the Bournemouth Corporation Tramways.

Glasgow Tramways Committee have accepted the tender of Wilsons and Union Tube Company, Limited, for standards, and that of P. and W. MacLellan, Limited, for coal-conveyers at Pinxton power-station.

Stockport Corporation have accepted the tender of the British Thomson-Houston Company for ten tramway-cars, for service between Stockport and Hazel Grove after that section has been reconstructed for electric traction.

Hudson and Bowring, Limited, of 33, Brazennose Street, Manchester, have received a further order from Rochdale Corporation tramways for their patent lifeguards. They have also an order for lifeguards to be fixed to the electric cars for the Colne tramways.

Stockport Tramways Committee have accepted a tender for £5 12s. 6d. per ton for rails for the Hazel Grove tramways. A Manchester paper remarks that in December they could have been purchased at £4 5s., which would have saved the town £1,178.

The J. G. Brill Company, of 110, Cannon Street, E.C., have recently received an order through the J. G. White Company, for 15 of their patented convertible cars, 25 ft. 9 ins. over the body, for the Manila Electric Railroad and Light Company, Philippine Islands.

The Dublin Town Council have accepted the recommendation of the Special Committee that was appointed to dissect and report on the various tenders submitted for the large extension of their refuse destructor plant, and have unanimously accepted the tender of Meldrum Bros., Ltd., of Timperley.

Messrs. Walter Scott and Middleton, of Westminster, have received a contract for the extension of the City and South London Railway from Islington, *via* King's Cross, to Euston. The extension is about a mile in length, and the price of the contract is said to be between £300,000 and £400,000.

The Peckham Manufacturing Company, of 34, Albemarle Street, London, W., informs us that they have received advice from their New York office that the Peckham Manufacturing Company have just closed a contract with the Brooklyn Heights Railway for 812 of their M.C.B. trucks, to be used for their passenger and goods cars.

J. G. White and Company, Limited, who constructed the Bournemouth Corporation Tramways in 1902, have received the contract for the extension of the system to Christchurch. There are six miles of track and three of route, and the amount of the contract is £39,000.

Dick, Kerr and Company, Limited, have the permanent way contract for the extension of the Rothesay Electric Tramways to Ettrick Bay, at £15,767. It is a condition of the contract that the work shall be completed within two months. The tramway company will do the overhead equipment themselves.

Messrs. Mountain and Gibson, of Elton Fold Works, Bury, Lancashire, have secured the contract from the Glasgow Corporation Tramways Department for 100 of their M.G. 21 E.M. electric motor trucks, fitted complete with steel tyred wheels and steel axles. These trucks are for 100 new cars which the Glasgow Corporation are themselves building.

South Shields Tramways Committee have recommended that tenders be invited for ten cars to be delivered by December 1 next, and that the last day for submitting tenders be March 13. The number of applications received for specifications in connection with the tramways is as follows: Permanent way, 24; copper binding, 16; cables and overhead equipment, 21.

Yarmouth Tramways Committee have recommended the acceptance of the following tenders in connection with the Gorleston tramways:

Cars—Brush Electrical Engineering Company, Limited	£5,646
Overhead Equipment—British Electrical Equipment Company, Ltd.	2,357
Rail Bonds—W. F. Dennis and Company	480
Granite Setts—T. Small and Company ...	500 tons at 20s. 6d. per ton

Erith District Council have accepted the following tenders in connection with their electric tramways undertaking:

Overhead equipment, etc.—Brush Electrical Engineering Co., Ltd. (Provided that the contractors undertake to complete the works within 13 weeks from date of order to commence.)	£4,217 0
Underground feeder cables, etc.—Callender's Cable and Construction Company, Limited, for vulcanised bitumen cables ... ... (and further sum of £51 16s. for additional two years' maintenance),	2,590 4
Rotary converters, etc.—British Westinghouse Company, Limited...	1,545 5

Messrs. Gawthorp and Company, of St. George's Sign Works Leeds, have supplied their Gawthorp's patent railway destination indicators to King's Cross and Leeds stations of the Great Northern Railway; also to Paragon station, of the North Eastern Railway at Hull. Messrs. Gawthorp and Company have also granted a license to the London and North Western Railway Company to manufacture for their own use Gawthorp's patent destination indicators.

Leith Corporation have accepted the tender of Messrs. Hadfields' Steel Foundry Company for tramway crossings at £4,466, and that of Messrs. John Dennis and Company, Dalkeith, for the erection of the new chimney at the power-station. The town clerk was instructed to write to the Brush Electrical Engineering Company and the British Thomson-Houston Company, who are building the cars, informing them that the Council have decided not to have the combined arrangement of folding-step and collapsible gate, as tendered for, but to have the independent arrangement for lifting by hand.

The Paterson Engineering Company, Limited, of Amberley House, Norfolk Street, London, W.C., have recently supplied Paterson purifiers to Messrs. Babcock and Wilcox, Limited, for H.M. Dockyards, Pembroke, and for Gosport and Fareham Tramways; to Messrs. Belliss and Morcom, Limited, for their Ledsam Street works; to Messrs. Danks and Company, for H.M. Dockyards, Chatham; to the Electric Construction Company, for H.M. Dockyards, Gibraltar; to Messrs. Mirrlees Watson and Company, for Partick electricity works: to Messrs. Crompton and Company, for Ultadunga Station, Calcutta; and to the Earl of Rosslyn's Collieries Company, Limited, etc.

Destructors for Middleton.—A special joint committee was recently appointed, consisting of members of the Health Committee and Electricity Committee, to report on the various tenders sent in for the erection of a refuse destructor to work in conjunction with the electric light station, and this committee recommended the acceptance of the tender of Messrs Meldrum Bros., Ltd., of Manchester. The contract will include the erection of a bridge across the river, and a Meldrum Simplex regenerative destructor. The Council at a subsequent meeting unanimously accepted the recommendation of the special committee.

Keighley Corporation have received the following tenders for two tramway cars:

Brush Electrical Engineering Company, Ltd., Loughborough (accepted)	£1,080
Hurst, Nelson, and Company, Motherwell	1,134
British Thomson-Houston Company, Rugby... ... ... (Not to specification.)	1,078
Dick, Kerr and Company, London	1,120
Raworth's Traction Patents, London ... ... (Not to specification.)	1,300
Thomas L. Scott and Company	1,270
British Westinghouse Company, Limited, London	1,120

Bradford Corporation have accepted the following tenders for the supply of miscellaneous stores required by the tramways department during the current year:

Electrical accessories ...	General Electric Company, Limited, Manchester.
Oils, grease, etc.	S. Miller.
Lamp fittings	Verity's, Limited, Manchester.
Iron castings	Thornton and Crebbin.
Malleable-iron castings ...	T. Gameson, Walsall.
Steel castings...	J. Wells, Keighley.
Cables and wires	W. F. Dennis and Company, London.
Bolts, nuts, washers, etc. ...	Wood and Saberton.
Transfers	London Transfer Depôt, Snow Hill, London.
Trolley poles	S. Dixon and Sons, Limited, Leeds.

The Brush Electrical Engineering Company, Limited, have recently closed the following contracts:

Leith Corporation, 18 double-deck car bodies, with Brush trucks and equipments.
Perth Electric Works (per British Electric Plant Company). a 500 KW. Brush-Falcon three-crank engine.
Port Elizabeth (per Davis and Soper) power-house plant, consisting of three 400 KW. steam turbo-electric generators, condenser, pumps, pipework, etc.
170 car bodies and trucks for Belfast, through Messrs. J. G. White and Company.
Five double-deck car bodies, with radial trucks and Brush motor equipments, for the Middleton Electric Traction Company.
Two double-deck car bodies, with Brush trucks and B. T.-H. equipments, for Keighley Corporation.
Nine radial trucks for new tramcars for Rochdale Corporation.
Tramway overhead equipment (£4,217) for Erith District Council.

Dover Town Council received the following tenders for the construction of the permanent way, overhead equipment, and feeder cables for the Dover and River Light Railway. The acceptance of the British Electric Equipment Company's tender was announced in our issue of February 9:

	With chalk and clinker ballast.	With beach ballast.
R. and G. Bisley	£13,460 0 0	£13,690 0 0
S. Pearson and Son, Limited	14,570 16 5	14,570 16 5
George Holloway	12,589 6 3	13,185 0 0
R. Woods and Company	12,502 10 0	—
G. Whimpey and Company	13,230 14 3	13,386 0 0
British Electric Equipment Company (accepted)	10,353 2 8	10,408 17 9
Wm. Griffiths and Company, Limited...	11,811 19 0	12,104 0 0
Thomas G. Starkey	13,193 12 10	13,157 19 10
George Law	12,994 0 0	13,229 0 0
George Trentham	14,880 0 0	15,000 0 0
R. W. Blackwell and Company, Limited	13,064 6 6	13,181 6 6
Thomas L. Scott and Company... ...	12,120 6 7	—
Dick, Kerr and Company, Limited ...	12,883 4 0	13,083 4 0
Fry Brothers...	14,467 7 7	—

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FINANCIAL REPORTS.

Dublin and Blessington Steam Tramway Company.—The ort for the half-year states that the gross receipts amounted to £3,716, and the expenditure to £3,094. This leaves a sum of £622 net profit for the six months, which the directors propose to place to the credit of the baronies.

Dublin and Lucan Electric Railway.—The report for the half-year states that after providing for debenture interest there is an available balance of £1,425 14s. on the half-year, out of which is recommended the payment of the half-yearly dividend on the 5 per cent. preference shares, and a further half-year's dividend of a similar amount on the same shares to clear off all arrears on them.

Carlisle Tramway Company.—The revenue account of this company for the past year shows a surplus of £2,949, a decrease of £68 compared with 1903, and after providing for debenture interest, etc., £1,555 is available for distribution. The directors propose to add £500 to the depreciation fund, and to carry forward £1,055. The car-miles run in 1904 were 359,756, the number of passengers carried 2,935,002, and the total receipts amounted to £10,713.

Newcastle Tramway Finances.—Mr. Easton, acting general manager to the Newcastle Corporation Tramways, estimates that in the ensuing year the receipts will show an excess of £79,472 over the ordinary expenditure. The balance will be more than swallowed up, however, by the expenditure of £32,958 on maintenance work and £67,142 on the payment of interest and in redemption of loans. The traffic expenses are 3·89d. per car-mile, as against 2·92d. in Salford, 3·36d. in Manchester, and 2·89d. in Glasgow.

Aberdeen Suburban Tramways Company.—The directors recommend that the balance of £1,357 4s. should be carried forward to the next half-yearly account. The company will by that time have had the experience of a full year's working of the lines, and may then determine how the balance at credit of profit and loss account should be dealt with. The traffic on the company's lines continues to be well maintained, and to cope with the heavy traffic which may be expected in the summer months, the directors have given an order for the construction of three new cars with covered tops.

Lincoln Tramways Company.—The report of the liquidator (Alderman E. Pratt) in the voluntary liquidation of the Lincoln Tramways Company, Limited, shows the total receipts to be £11,561 17s., of which £10,437 10s. was the agreed purchase price given by the Corporation. The other principal item is £957 17s. 10d., £517 10s. 5d. of which was on deposit at bank to reserve fund, and £440 7s. 5d. realised on sale of India Stock. The total disbursements amounted to £8,606 17s. 7d. Deducting this from the receipts, £11,561 17s., there is a balance of £2,954 19s. 5d. The liabilities to be provided for out of this amount to £310.

Imperial Tramways Company, Limited.—The report states that the net revenue account for the year shows an available balance of £41,655, and after payment of interest on the debenture stock for the whole year, and interim dividends on the preference and ordinary shares in respect of the half-year to June 30 last, amounting together to £26,168, it is proposed to appropriate the balance as follows: Dividend at 6 per cent. per annum on the preference capital (paid on January 2 last), £5,700; final dividend at 10 per cent. per annum (making 9 per cent. for the year) on the ordinary capital, £9,500, and to carry forward £287. The reserve funds now amount to £121,871.

Chatham and District Light Railways Company.—The report for the half-year ended December 31 last, to be presented at the meeting on the 7th inst., shows receipts £16,381, and expenses £10,029, leaving £6,352. To this must be added £745 brought forward from June 30, 1904, making £7,097. The directors recommend a dividend at the rate of 3 per cent. per annum on the ordinary shares for the half-year, carrying forward £1,700. The short extension line to Rochester, referred to in the previous report, was opened for public traffic on December 22 last, and a substantial increase in the receipts has resulted. The agreement between the Kent Electric Power Company and this company has fallen through. The special deposit account of £3,000 has been transferred to reserve for depreciation.

The London General Omnibus Company report that the gross receipts in the past half-year amounted to £632,075, a decrease of £6,745 on the corresponding period of 1903, whilst expenses came to £582,811, a decrease of £708. Including £10,072 brought forward, and £9,288 from interest, the profit was £68,624, of which £5,700 was required for debenture interest. £20,000 has been transferred to the motor fund account, and the directors have declared a dividend at the rate of 8 per cent. per annum, carrying forward £11,293. The average cost of feeding and bedding each stud of horses in the past half-year was £133, against £138 in 1903, and £152 in 1902. The directors have watched the improvements which have been made in the methods of mechanical traction. They have now decided to make extensive trials, and have several types of motor omnibuses on order for that purpose.

Great Northern, Piccadilly, and Brompton Railway.—Sir Henry Fowler, M.P., presided on Thursday, February 14, at the half-yearly general meeting of this company, held at Hamilton House, Victoria Embankment. In moving the adoption of the report, he said the company had spent, during the six months ending December 31 last, £644,896, the whole of which, with the exception of a very small sum, had been expended on land and compensation, £19,000, and on construction, including engineering, nearly £621,000. The engineers' reports showed that the work was proceeding both satisfactorily and rapidly. It was impossible to tell at present at what date the railway would be completed, but he hoped the directors would be able to give some definite idea of the time when they met the shareholders at the next half-yearly meeting. A dividend at the rate of 4 per cent. per annum, free of income tax, was recommended. The report was adopted.

North London Railway.—The report states that the gross receipts for the half-year amounted to £261,240, a decrease of £19,005; and the expenses to £166,365, an increase of £5,891: the percentage of working expenses to gross receipts being 63·68 against 57·26. The decrease in the receipts from passenger traffic is attributable to the competition of the Great Northern and City Railway, depression in trade, and the dense fogs which prevailed during the latter part of the year. The result of the half-year's working, after providing for interest on the debenture capital and other prior charges, and debiting the reserve fund with £3,000, is a balance to the credit of net revenue of £75,907 19s. 4d., from which it is recommended that dividends for the half-year be declared at the rate of 4½ per cent. per annum on the first and second preference consolidated stocks, and at the rate of 5 per cent. per annum on the ordinary stock, making the dividend for the year 5½ per cent., leaving £3,673 to be carried forward, against £3,179 in 1903.

North Metropolitan Tramways Company. The report for the half-year ended December 31 states that the gross receipts amount to £319,275, and the total expenditure to £301,517, leaving as net profit £17,758. The balance, together with £223 brought forward and the amount received from the Metropolitan Electric Tramways, Limited, for debenture interest, is £20,606, and the sum available for division, after providing for debenture interest, is £17,980. It is proposed to pay a dividend at the rate of 4 per cent. per annum, on the ordinary shares, subject to a tax. The balance of £233 will be carried forward. The sum of £18,157 has been charged against revenue for maintenance of the permanent way. Referring to the agreement with the West Ham Corporation for the purchase of the Company's lines and depôts within the borough, which was submitted to and approved by the shareholders on February 11, 1903, the purchase of the lines was carried into effect on June 30 of that year, and the directors have to report that the price to be paid for the depôts has now been agreed with the Corporation at the sum of £63,000, and that the sale will be completed at an early date. The negotiations with the Leyton Council have not yet been concluded.

Baker Street and Waterloo Railway.—The prospectus was published on Wednesday, February 15, of an issue of £500,000 4 per cent. perpetual debenture stock of the Baker Street and Waterloo Railway Company. The authorised share capital of the company is £2,673,000, of which £1,641,850 has been issued and fully paid. There is power to issue 4 per cent. perpetual debenture stock to the entent of £890,000. The £500,000 of such stock now dealt with was offered for sale by Messrs. Speyer Brothers at the price of £96 per cent. Mr. Stephen Sellon, in a report, estimated that the railway will carry 35,000,000 passengers per annum, and taking the average receipts at 1·86d. per passenger and the miscellaneous receipts at £10,000 per annum, the total gross revenue would amount to £281,750. Mr. J. R. Chapman, engineer-in-chief of the Underground Electric Railways Company of London, estimated that the total working expenses would amount to £135,281 per annum. This would leave a net revenue of £146,469. Interest at 4 per cent. on the total borrowing powers of the company would amount to £35,600, leaving a surplus net revenue of £110,869. The debenture stock offered for sale forms part of the stock payable to the Underground Electric Railways Company of London under construction contracts, and has been purchased from them by Messrs. Speyer Brothers.

North Eastern Railway Company.—The half-yearly report states that the expenditure on capital account during the last six months has been £696,647. The total revenue amounted to £4,832,764, a falling off of £36,966 as compared with the correspoding period of the previous year, while the total expenditure at £3,070,535 shows a reduction of £19,542. The net receipts were £1,762,229, a decrease on the corresponding period of £1903 of £17,424: and £40,875 was brought forward, a decrease of £4,412. After providing for interest, rents, and other preferential charges, there remains a balance of £948,493 available for dividend on North Eastern consols, on which the directors recommend a dividend at the rate of 5¾ per cent. per annum, leaving £45,538 to be carried forward. Against decreases of £42,386 and £15,406 under the heads of locomotive power and traffic expenses respectively must be taken the expenditure of £22,525 on the working of the electric trains. The steam train mileage was 13,894,289, a decrease of 675,232, but the

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electric trains ran 588,786 miles. During the half-year the company have carried on the Newcastle and Tynemouth suburban lines, which are now worked by electricity, 675,000 more passengers between stations on these branches than in the corresponding half of 1903. The directors consider that the results of subsituting electricity for steam in working the passenger traffic on these lines have so far been satisfactory as regards receipts and expenses.

London Road Car Company.—At the half-yearly meeting of this company, on February 21, the chairman, Mr. J. H. Moore, in moving the adoption of the report, called the attention of the shareholders to the question of seriously grappling with the subject of substituting mechanically-driven vehicles for the present horse cars. Although sufficient time had not yet elapsed for the Board to give definite figures as to the cost of working, no doubt existed as to the possibility of motor-cars being worked at a cheaper rate than horsed vehicles, or as to the additional convenience to the public which would accrue from the change. The directors had entered into contracts with two leading motor companies for the exclusive supply to them of vehicles for use in London, and within a radius of 25 miles outside. This would place the Road Car Company in the first position in regard to motor omnibuses in the streets of the metropolis. The cars would be constructed with every regard to the comfort of both inside and outside passengers. Already orders had been given for the construction of a first instalment of 50 cars, and the directors looked forward with the greatest confidence to the result of the new departure. Obviously, however, new capital would be required for the undertaking, and the Board consequently proposed to issue the balance of the company's share capital, £116,004. Already sufficient money had been obtained for present requirements. There was little doubt that the balance would be subscribed whenever necessary. The report was unanimously adopted.

Tyneside Tramways and Tramroad Company, Limited. The half-yearly report states that the surplus of receipts over expenses, after paying interest on mortgage debentures, etc., is £1,535 8s. 8d., which, together with the balance carried forward from last half-year, viz., £328 14s. 9d., makes a total to the credit of profit and loss account of £1,864 3s. 5d. Out of this the directors propose the payment of a dividend at the rate of 2 per cent. per annum, and to place £600 to the credit of reserve fund for renewals, depreciation, and other contingencies, which will leave £58 6s. 10d. to be carried forward. The traffic receipts for the year ending December 31, 1903, were £16,362 7s. 7d., while those for the year ended December 31, 1904, were £19,728 15s., showing an increase in traffic receipts of £3,366 7s. 5d., notwithstanding that during the past six months the company has had to meet the competition of the North Eastern Railway Company's electrified lines. The directors would repeat that the application to Parliament for running powers in connection with the lines of the Newcastle Corporation involved abnormal charges against revenue as well as against capital, a portion of these charges being borne by the half-year under review. The running powers authorised were not put in force until the end of August, and then on only two out of the three routes. The results have, however, come up to expectation. The whole of the track, overhead line, and rolling stock has been kept in thorough repair during the past year. The directors are making application to Parliament this session for a Bill to enable them to issue the remaining capital of the company in ordinary or preference shares.

The Metropolitan District Railway Company report that the total receipts for the half-year ending December 31 were £197,417, a decrease on the corresponding half of 1903 of £2,621. The working expenses were £114,212, a decrease of £7,478. The revenue account shows a profit of £83,205, an increase of £4,858. Owing to the adoption of a new mode of dealing with season tickets, rendered necessary by the early institution of zone fares, the net revenue for the half-year is insufficient by £6,575 to meet in full the fixed charges, and to pay to the 4 per cent. guaranteed stockholders a dividend at the rate of £1 7s. 6d. per cent. per annum, to which they are entitled out of the share of the District Company of the revenue of the City Lines and Extensions Railway for the half-year. To meet this deficiency it is proposed to charge the amount (£6,575) to capital account, and at the same time to credit to capital account £23,978, which represents premiums on the issue of stocks, and which has for some years stood in suspense. Notwithstanding the unavoidable interruption to traffic caused by the electrification of the railway, the company has carried 367,892 more passengers this half-year than in the corresponding period of last year, the number being 24,758,858 in addition to the season-ticket holders, and during the year 1,917,565 more than in 1903. The work of electrification is nearing completion. The directors are assured by their engineers that within two months the whole of the works necessary to operate the railway electrically will be finished. The various electric railway services will then be commenced as rapidly as the car contractors deliver the cars.

Bristol Tramways and Carriage Company. - The report of the directors of this company for the year ending December 31, 1904, states that the gross receipts for the year amount to £250,799 15s., and the working and general expenses and renewals are £168,798 18s. 2d., leaving a net revenue of £91,000 16s. 10d. The following amounts have already been distributed, viz., interest on 4 per cent. mortgage debenture stock and deposits, £11,415 14s. 10d.; dividend on 4 per cent. preference shares, £19,026 16s. 8d.; interim dividend at the rate of 8½ per cent. per annum (subject to income-tax) for the half-year ending June 30, £20,231 16s. 5d.: £50,668 6s. 11d. It was proposed to appropriate the balance as follows: Final dividend for half-year at the rate of 9½ per cent per annum (subject to income-tax), £22,562 10s., addition to reserve for contingencies fund, £17,769 19s. 11d.—£40,332 9s. 11d. —£91,000 16s. 10d. The interest on investments has been carried to the credit of contingencies fund, as also the sum of £3,318 17s. 10d. received on income-tax appeal, and the values of the investments having been adjusted to market prices at December 31 last, the reserve fund then totalled £135,901 18s. The company's investments have thus increased by £23,768 9s. during the past year, and with the addition now proposed will be further augmented to £153,671 18s. 11d. The receipts from the tramways department show an increase of £3,441, and those of the carriage department an increase of £2,317 over the previous year's takings. The total number of passengers carried during the year on the company's cars and omnibuses was 45,312,373, an increase of 920,934. The company obtained their Act of Parliament last session, authorising the extensions of about ten miles of route, including the principal roads out of the city, Parliament having approved the company's proposals that as to about nine miles the concession should be for at least forty-two years

London United Tramways (1901), Limited. - The report for the year ended December 31, 1904, which was submitted at the annual meeting, states that gross receipts have amounted to £296,235, and working and general expenses and renewals to £176,188, leaving, with the balance brought forward from last account, a net revenue of £120,834. After payment of debenture interest and dividend on the 5 per cent. preference shares, there remains £42,087 (including £3,750 net premiums on new preference shares). An interim dividend at the rate of 6 per cent. per annum has been paid on the ordinary shares, and it is now proposed to pay a final dividend at the rate of 6 per cent. per annum, placing £5,000 to credit of reserve fund, and carrying £563 forward. Gross receipts show an increase of £15,993, and operating expenses have decreased by £203, notwithstanding the larger mileage open as compared with the previous year. The total number of passengers carried was 48,126,727, an increase of 2,833,254. Debenture interest and preference dividend together absorb £82,497, as compared with £58,826 in the previous year. This arises in consequence of the expenditure of capital which the directors have considered it expedient in the company's interest to incur (as explained in their interim report of August last) for the purpose of carrying out important road improvements and widenings on various parts of the company's system. These works afford valuable facilities for the conduct of the present traffic, and would have involved a greatly enhanced capital outlay if deferred to future years, when they must become essential to the proper development of the company's business. The extension from Southall to Uxbridge *via* Hayes and Hillingdon, and also the connecting line from Hammersmith Broadway *via* Askew Road, were opened for public traffic in June last, and the results have fully realised anticipations. During the summer months especially this attractive route was largely used by passengers who availed themselves of the new facilities for reaching the town of Uxbridge. The Bill promoted by the company in the last session of Parliament to authorise an extension from Hounslow to Staines received the Royal assent on August 15. Preparations are in progress for the construction of the authorised tramways in Kingston, Surbiton, the Maldens, and Wimbledon, and between Brentford and Hanwell. These Surrey lines will link up important centres of population, and will connect with the London County Council electric tramways system at Tooting, and over Kingston Bridge with the company's tramways in Middlesex and London. At the conclusion of the ordinary meeting an extraordinary meeting will be held for the purpose of sanctioning various Bills.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

Annual Meeting.

The annual meeting of this Association was held on Friday afternoon, February 10, at the Society of Arts, John Street, London, W.C. Mr. Alfred Baker (general manager of Birmingham Corporation Tramways) the retiring president, occupied the chair, and delivered a brief address moving the approval of the Council's report, which was adopted. The following additional members of the Council were elected: The Hon. Arthur Stanley, M.P., Lord Vaux of Harrowden, Messrs. H. England, J. B. Hamilton, J. H. Rider, and S. Sellon. The Hon. Arthur Stanley, M.P., the new president, then took the chair, and in the course of some interesting remarks urged the desirability of union among tramway interests. Alluding to the threatened motor omnibus competition he expressed the opinion that nothing cheaper than a metal wheel on a metal rail would be found. A cordial vote of thanks was awarded to Mr. Baker for his valuable services during the year.

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TRAMWAY AND LIGHT RAILWAY NOTES.

ASTON MANOR.—At a special meeting of the Aston Town Council, held on Friday, February 10, the Council adopted a report of the Public Works Committee embracing a scheme which had been prepared by their consulting engineer (Mr. Robert Green) for the reconstruction of the remaining tramways within the borough, including street improvements. The total cost of the work, including the overhead electric equipment, is estimated at £63,270. The Council approved the plans and sections of the work prepared by the engineer, and authorised tenders to be obtained.

BELFAST.—Proceedings were commenced at the Surveyors' Institution, Westminster, on February 6, before Mr. L. L. Macassey, sitting as sole arbitrator between the Belfast Tramways Company and the Corporation of that city, arising out of the purchase by the authority of the company's undertaking. Mr. C. A. Cripps, K.C., M.P. Mr. C. Hutchinson, and Mr. F. Richardson appeared for the company: and Mr. Balfour Browne, K.C., and the Solicitor-General for Ireland (Mr. J. H. Campbell, K.C., M.P.) represented the Corporation. The claim, which amounted to nearly £400,000, included an item of £345,971 for the company's undertaking, about £20,000 for two other undertakings, £74,216 three years' unexpired profits, and £7,500 compensation to directors, manager, and secretary. The full figure was £452,395, but deducting the amount of the principal moneys secured by the company's outstanding debentures (£60,000) the total claim was £392,345. The proceedings were concluded on February 16. The arbitrator's decision had not been delivered up to the time of printing.

BIRMINGHAM.—In connection with the acquisition of the Balsall Heath lines by the Birmingham Corporation, it has been found possible to avoid the uncertainties and cost of an arbitration by an agreement with the Company as to the terms of purchase. The Corporation are to pay the City of Birmingham Tramways Company £20,000 for the lines, and £16,000 for the Kyott's Lake Road depôt, but the Company is to afford facilities for the electrical conversion of all the steam and horse routes in the city during the period between now and the expiration of the leases in 1906.

EDINBURGH AND GLASGOW.—Mr. Hall Blyth, Chairman of the Edinburgh and District Tramways Company, speaking at the annual meeting recently, referred to the frequent criticisms of the cable system, and defended it against the charge that it was effete and obsolete. What had handicapped the company, he said, was the gross extravagance of the Corporation of Edinburgh. In their initiation of the system, he had no hesitation in saying that a very large sum might have been saved on the original capital account if the matter had been gone about in a proper business-like way. They all had heard town councillors frequently say, "What does it matter to us? Seven per cent. upon our outlay is a very fine return." Capital had been expended, and the company had to pay 7 per cent. That was what was handicapping the company. He drew a comparison between the systems of Edinburgh and Glasgow. The working expenses in Edinburgh per car-mile were 5·61d. In Glasgow, after allowing for maintenance of the permanent way, the cost was 6·16d. per mile run. The traffic receipts per single mile of track in Edinburgh were £5,732 as against £5,318 in Glasgow, so that in both cost per mile run, and traffic receipts, Edinburgh was distinctly better than Glasgow. With regard to speed, the Edinburgh cars ran at an average speed of 9½ miles per hour, and that compared very favourably with electric systems throughout Great Britain. In comparison with all large towns in England and Scotland, the Edinburgh cars were running at a cheaper rate per mile, and were earning more per mile of single track. —Arrangements have been completed between the Edinburgh and District Tramway Company and the owners of the Musselburgh Electric Tramways, whereby the service of parcel delivery at present carried on in connection with the Edinburgh tramways, will be extended over the Musselburgh system. The Edinburgh tramway officials state that their parcel traffic has grown enormously since it was started in October last. 8,000 parcels were dealt with during Christmas week.—Representatives of the competing schemes for the proposed running of electric tramways to Queensferry have been received by the Tramway Committee of Edinburgh Town Council. The representatives of the Edinburgh Suburban Electric Tramway Syndicate (with Mr. W. M. Colam, engineer, and Mr. Peter Macnaughton, S.S.C., secretary) were first received, and subsequently the National Electric Construction Company (with Mr. Buchan, engineer, and Mr. Guild, W. S.). It is understood that the former company propose to run lines from Princes Street (by way of Belford Bridge) and Comely Bank, converging at Craigleith, and from Bonnington by way of the Ferry Road to Davidson's Mains, where the city route would be met, while the National Construction Company are understood to favour Queensferry Street and Goldenacre as Edinburgh termini. While the Committee expressed no opinion with regard to the merits of either scheme, both deputations left the Council Chambers expressing themselves satisfied with their reception.

GLASGOW AND PAISLEY.—Lord Balfour of Burleigh, on Monday, February 20, heard parties at the Westminster Palace Hotel in regard to the arbitration pending between the Corporation of Glasgow and the Paisley District Tramways Company regarding the exercise by the Corporation of running powers over a mile of track belonging to the company. A short time ago his Lordship issued an award, but the parties were not agreed upon the interpretation of it, in so far as concerned the question of the cost of the electrical energy for the running of the cars. Monday's proceedings, which were held in private, were for the purpose of ascertaining his Lordship's determination as to whether the Corporation, in addition to their other working expenses, were to be allowed a sum to cover the cost of the electrical energy. Lord Balfour intimated that, while he could not make any addition to the award in fixing the working expenses which he previously allowed to the Corporation, he had intended that to those expenses would be added a sum to cover electrical energy.

HALIFAX.—The tramway extension, constructed by Halifax Corporation from Sowerby Bridge to Triangle, was inspected on Tuesday, February 7, by Major Druitt, of the Board of Trade, and passed as satisfactory. The line was opened for traffic on the following Friday. With this extension, which is about a mile in length, the Halifax tramways system comprises a total of about 34 miles of route.

HASTINGS.—The Hastings and District Tramways Company have power to equip the line on the front electrically on some system other than the overhead. They intended, however, to ask for parliamentary powers to equip that line on the latter system; but in deference to strong local feeling against the proposal, they have withdrawn it from the bill.

HULL.—The Tramways Committee, at a special meeting on February 20, decided to contribute £19,500 out of the year's profits on the working of the Corporation Tramways, to the relief of the rates.

LEEDS.—The Tramway Committee has adopted a new scheme of fares. There will be a uniform penny stage of two miles. An experiment will be made with halfpenny fares on two more routes, and further concessions will be made to workmen and children. A workman will now be able to purchase a return ticket available for the second journey at any hour after noon. With regard to the new halfpenny stages the new arrangement will result in dividing a uniform two-mile penny stage into three equal halfpenny stages.

LEITH.—The construction of Leith Corporation tramways was commenced on Monday, February 6. The work is being carried out by the Corporation, under the direction of Mr. John More, the consulting engineer; Mr. Peden Rutherford, electrical engineer; and Mr. Findlay, burgh surveyor. The first section to be dealt with is Pilrig Street, upon which at present there is no tramway line. The section of the horse tramway between Bonnington and Newhaven will then be replaced by the new lines. A large quantity of material is already forward.

LIVERPOOL.—At a meeting of the Liverpool City Council, on February 8, a recommendation of the Tramways Committee that a tender for the excavation for the foundations of the new tramways offices, Hatton Garden, Liverpool, for the sum of £3,690 be adopted, was approved, after some discussion. A further recommendation that plans and elevations of the proposed new offices, as submitted, be adopted, gave rise to a prolonged discussion. It was ultimately decided to refer the matter back, and authority was given to the Committee to advertise for competitive designs for the new building.

MANCHESTER.—Manchester Corporation Tramways Committee has recently inaugurated a parcel carrying system on somewhat novel lines. The parcels are not carried on the platform of the ordinary car, but a special car has been built for the specific purpose. It is similar in style to the milk vans on the railways, with a driver in front and a conductor in the rear. There is naturally a hostile feeling to the scheme among the local parcel carriers, who are hopeful that the difficulties in delivery from the various centres will be too much for the Tramways Committee. The new parcel van is illustrated on another page of this issue.

NEWCASTLE.—The Tramway Committee in dealing with the estimates for the ensuing year have decided that the track should not be anchored except in such places and such times as the track is taken up for the purpose of repair. Consequently the sum of £4,500 included in the estimates for the purpose of anchoring and welding the joints will stand over for further consideration.

PATENT LIST.

Specially abstracted for "The Tramway and Railway World" from the Official Journal of Patents.

*** If the inventions have been communicated the names of the communicators are given below in italics.

APPLICATIONS.

Applications for Letters Patent have been filed as follows:

1,764 Railway and tramway wheels—R. Hyde and J. R. Hyde.
1,820 Electro-dynamic traction systems J. Dulait, C. Zelenay, and L. Rosenfeld.
1,866 Maximum traction truck—A. S. Nelson.

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1,876 Apparatus for controlling electric cars—F. Lydall.
1,890 Dry seats for tramcars—T. Egan and J. Lawson.
1,912 Electric railway system—F. E. Kinsman.
1,923 Rail joints for railways and tramways—H. Booth.
1,951 Automatic block-signalling for electric railways—F. Townsend.
2,172 Electric traction systems—W. S. Boult.
2,378 Anchors for tramway rails—T. I. Rudman.
2,475 Automatic systems of signalling for electric railways—S. M. Young.
2,488 Brakes for tramcars—E. Peckham.
2,506 Trolleys of electric tramcars—J. N. Hicks and M. Galvin.
2,518 Renewable lip-guard to tramway rails—A. Brown and L. W. Crosta.
2,603 Trolley pole controller—S. E. Gunyon (*Magney Manufacturing Company*).
2,765 Automatic points for tramways or railways—E. Allen and Company, F. Bland, and W. E. Robinson.
2,780 Tramway and railway points—J. Leighton.
2,816 Automatic lubrication of trolley wheels—L. J. Bedford.
2,839 Tramways—J. Eccles.
2,864 Installations for controlling electric trains—Siemens Brothers and Company and C. F. Jenkin.
2,882 Double-decked tramcars—J. A. de Macedo.
2,888 Trolley heads with wire-finding apparatus—J. T. Cherry and E. H. Clive.
3,003 Tramway rails, points, and crossings—A. Brown and L. W. Crosta.
3,009 Electric tramway conduit systems—A. L. C. Fell and J. H. Rider.
3,075 Vehicles for conveying on narrow-gauge railways broad-gauge vehicles—E. R. Calthrop.
3,129 Lifeguard for electric cars—S. R. Cameron.
3,184 Installations for controlling electric trains—Siemens Brothers and Company and C. F. Jenkin.
3,255 Method of clearing tramway rails of snow and other impediments—P. Croft.
3,293 Electric traction on a shallow conduit system—S. G. Bennet.
3,392 Trolley wires—G. J. Conaty and H. Hartley.
3,437 Method for attaching anchor plates, joint plates, or sole plates to tramway rails—W. H. Smith.
3,521 Fenders for tramcars—G. Pellizzoni.
3,523 Steps for railway and tramway carriages—J. G. Robinson.
3,538 Sectional system for third rail on electric railways—J. Reed.
3,555 Cast-iron or steel supports for tramway pavements—M. Robinson and J. Dodd.
3,567 Signalling for steam and electric railways—J. J. Munro and T. Common.
3,568 Trolley change guide for tramcars—J. Stewart.
3,614 Trolley heads—C. E. France.
3,630 Radial trucks for tramcars—E. E. Cook.
3,642 Sand valve for tram and motor cars—L. Baron, F. T. Birtwistle, and W. H. Spencer.
3,747 Dry seats for tramcars—J. M. Martin.
3,773 Lubricators for trolley wheels—J. Hensley.
3,795 Electric lighting of railway and tramway carriages—J. Stone and Company, Limited, and J. R. Quain.
3,847 Tramcar seats—C. Willocks, S. Broomhead, and W. Richardson.
3,871 Weather shield for tramcar and other drivers—J. Hunter.
3,872 Axle boxes of railway and tramway cars—H. Green.
3,885 Electric trolley harps—J. Hensley.
3,938 Railway and tramway crossing places—S. Chambers.
3,983 Bell-sounding instrument for punching, classifying, and recording tickets—W. P. Thompson.

Specifications Accepted.

The following applications, of which the specifications have been published, are now open to opposition by prior patentees or any other persons interested:

1904

818 Electric railway systems—British Thomson-Houston Company, Sporborg, Carter, and Cubitt.
2,435 Structural intersections and crossing-ways of tramways and railways—Kitchen.
6,365 Joints of tramway rails—Clark.
14,933 Mode of protecting life from the live-rail danger on electric railways—Curwen.
20,161 Sole plates and anchors for tramway rails—Walker and Grant.
1,860 Conductors of electric railways or tramways—Boardman.
2,288 Electric signalling apparatus for tramways and railways—Wilson and Marshall.
4,874 Trolley poles—Kilbourn and Flower.
18,644 Seats for tramcars—Owens.
22,404 Device for preventing broken trolley wires from falling—Kirwan and Quaney.
27,114 Gear for moving rail and conductor points on tramways—Virgin.
27,858 Brake mechanism for tramcars—Kling.
5,215 Trucks and brakes for tramcars—Cook.
7,159 Supporting devices for tramway and railway rails—Bullough.
12,729 Electric railways and motor vehicles therefor—Sayer.

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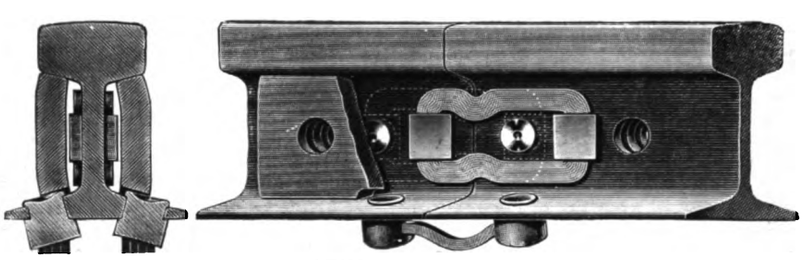

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TRAFFIC RETURNS.

TRAMWAY COMPANIES.

	1904. WEEKS ENDING Jan. 30.	Feb. 6.	Feb. 13.	Feb. 20.	1905. WEEKS ENDING Jan. 28.	Feb. 4.	Feb. 11.	Feb. 18.	AGGREGATE. Wks.	1905.	Increase or Dec.
	£	£	£	£	£	£	£	£		£	
Aberdeen Corporation	1,057	1,072	1,094	1,044	1,064	1,093	1,052	1,070	38	52,042	+ 5,782
Airdrie	...	...	206	200	192	195	204	194	7	1,963	− 10
Barcelona	1,415	1,553	1,627	1,644	1,831	2,013	1,940	1,910	7	13,526	+ 2,587
Barnsley	144	147	154	151	143	155	155	158	7	1,008	+ 29
Barrow	...	...	170	143	169	192	187	188	7	1,215	+ 62
Bath	474	466	518	461	481	511	535	547	7	3,733	+ 465
Birmingham, City of	5,118	5,098	5,316	5,151	5,037	5,303	5,534	5,392	7	35,752	+ 776
Birmingham and Midland	825	826	859	843	1,039	1,126	1,174	1,155	7	7,439	+ 1,585
Blackpool and Fleetwood	181	219	186	178	183	207	190	186	7	1,267	− 98
Blackpool Corporation	256	289	291	275	251	298	315	303	46	45,602	+ 6,110
Blackpool, St. Anne's, and Lytham	141	...	144	144	120	132	136	142	15	2,010	
Bolton Corporation	1,625	1,616	1,589	1,622	1,633	1,664	1,677	1,630	47	85,261	+ 461
Bournemouth Corporation	776	848	862	858	769	840	855	895	46	49,282	+ 2,183
Bradford Corporation	...	...	...	3,517	...	...	...	3,881	47	203,495	+ 29,545
Bristol	4,372	4,395	4,604	4,242	4,294	4,495	4,520	4,431	7	31,281	+ 182
Burnley Corporation	808	836	889	867	940	1,027	1,034	964	7	6,981	+ 1,116
Burton-on-Trent Corporation	282	296	302	290	269	295	287	292	46½	15,722	—
Calcutta	...	Rs. 36,342	35,796	37,380	...	38,447	36,475	39,063	6	247,990	+ 27,497
Carlisle, City of	176	166	170	163	125	141	138	144	7	1,022	− 166
Chatham and District	471	518	526	512	553	582	600	579	7	3,863	+ 330
Cork	385	396	377	381	392	405	415	450	7	2,772	+ 22
Devonport	441	450	458	419	399	433	446	424	7	2,981	− 93
Dover Corporation	161	154	169	162	161	164	163	169	47	10,211	− 130
Dublin and Lucan	91	99	95	94	89	96	98	91	7	648	+ 7
Dublin United	4,320	4,381	4,373	4,216	4,256	4,449	4,590	4,353	7	30,364	+ 467
Dudley—Stourbridge	718	713	732	733	693	758	785	767	7	4,936	+ 73
Dundee City	780	804	800	773	765	806	800	776	35	32,833	+ 294
East Ham U.D.C.	581	577	598	600	607	627	649	651	46	32,648	+ 1,788
Edinburgh and District	4,071	4,012	3,923	3,825	4,071	4,317	4,282	4,188	7	31,258	+ 2,756
Gateshead	852	880	863	844	840	885	893	862	7	5,869	+ 101
Glasgow Corporation	13,420	13,140	12,684	12,917	13 634	13,995	13,956	13,991	38	540,051	+ 26,550
Gravesend and Northfleet	193	203	216	208	175	186	191	186	7	1,249	− 133
Greenock—Port Glasgow	457	507	449	458	445	547	491	550	7	3,494	+ 367
Harrow Road and Paddington	200	220	238	229	203	215	227	228	7	1,527	− 40
Hartlepool	237	249	241	222	220	244	253	231	7	1,616	− 28
Hull Corporation	1,986	2,005	2,030	1,987	2,001	2,058	2,026	2,060	46	100,666	+ 10,978
Ilford Corporation	305	...	338	...	327	...	368	...	45½	20,127	+ 1,009
Ilkeston Corporation	119	126	118	122	103	108	101	100	47	6,195	—
Kidderminster	87	92	92	96	82	95	91	92	7	613	− 7
Lanarkshire	559	567	542	527	578	583	638	634	7	4,399	+ 321
Leeds Corporation	4,978	3,798	4,902	4,966	5,093	5,360	5,395	5,391	47	268,250	+ 15,297
Liverpool Corporation	9,334	9,648	9,471	9,257	9,560	9,817	10,030	9,772	7	68,653	+ 2,156
London County Council	8,848	9,373	9,661	9,653	11,598	12,585	12,372	12,878	47½	588,357	+ 131,915
London General Omnibus	19,924	20,700	21,074	20,752	20,430	21,851	21,924	22,315	6	126,712	+ 2,463
London Road Car	6,626	6,950	7,071	6,955	6,750	7,038	7,446	7,692	7	49,594	+ 1,495
Manchester Corporation	10,808	10,692	10,556	10,572	11,267	11,588	11,604	11,670	46	559,926	+ 26,567
Merthyr	186	192	192	187	182	178	178	179	7	1,167	− 97
Metropolitan	1,065	1,012	1,077	1,075	1,873	1,893	2,020	1,979	7	13,046	+ 5,792
Middleton	233	248	247	227	243	275	272	269	7	1,755	+ 159
Newcastle-upon-Tyne	3,509	3,583	3,481	3,433	3,492	3,661	3,555	3,513	7	24,714	+ 346
North Metropolitan	10,328	10,613	10,802	10,492	10,157	10,626	10,795	10,776	7	73,723	− 655
Oldham—Ashton	485	497	489	472	465	508	491	492	7	3,383	+ 27
Oldham Corporation	1,063	1,079	1,028	1,069	1,366	1,393	1,373	1,364	47	59,007	+ 4,400
Peterborough	104	108	118	104	93	101	106	102	7	679	− 47
Poole	206	213	211	229	198	215	214	228	7	1,454	− 27
Potteries	1,574	1,643	1,684	1,559	1,538	1,714	1,662	1,616	7	10,999	+ 290
Rossendale Valley	154	165	161	151	160	176	176	185	7	1,243	+ 131
Rothesay	37	39	39	37	36	37	46	40	7	300	+ 25
Salford Corporation	3,686	3,638	3,568	3,668	3,800	3,869	3,819	3,846	45	188,024	+ 9,180
Sheerness	40	47	47	46	50	49	55	55	7	347	+ 50
Sheffield Corporation	4,101	4,201	4,160	4,282	4,393	4,444	4,464	4,388	47	218,412	+ 5,797
Southampton Corporation	732	...	887	880	719	...	802	794	46	44,261	− 2,579
Southport	229	259	219	236	195	228	234	239	7	1,513	− 80
South Staffordshire	745	664	727	681	601	649	677	673	7	4,381	− 325
Sunderland Corporation	1,072	1,074	1,078	1,061	1,107	1,120	1,069	1,079	47	57,983	+ 1,472
Swansea	475	449	511	430	441	462	456	476	7	3,052	− 35
Taunton	44	48	49	44	35	39	40	37	7	267	− 47
Tynemouth	204	198	210	197	165	168	179	163	7	1,145	− 217
Tyneside Tramways and Tramroads	272	282	280	283	318	327	340	327	7	2,139	+ 256
Wallasey U.D. Council	571	583	571	568	609	646	650	631	46	34,198	+ 2,332
West Ham Corporation	...	...	...	...	1,018	1,052	1,102	1,079	51	49,446	—
Weston-super-Mare	23	31	21	22	26	22	26	28	7	176	+ 27
Wolverhampton Corporation	395	392	388	386	668	699	659	711	47	33,014	—
Wolverhampton District	336	321	332	333	328	352	361	346	7	2,293	+ 96
Worcester	99	110	282	265	234	259	262	254	7	1,693	+ 643
Wrexham and District	102	95	96	94	88	95	102	95	7	620	27
Yorkshire (Woollen) District	485	483	490	483	522	604	576	563	7	3 721	+ 423

RAILWAY COMPANIES.

	1904. WEEKS ENDING Jan. 30.	Feb. 6.	Feb. 13.	Feb. 20.	1905. WEEKS ENDING Jan. 28.	Feb. 4.	Feb. 11.	Feb. 18.	AGGREGATE. Wks.	1905.	Increase or Dec.
	£	£	£	£	£	£	£	£		£	
Brecon and Merthyr	1,877	1,807	1,738	1,810	2,083	2,025	2,065	2,053	7	14,387	+ 1,486
Cambrian	5,202	4,975	4,596	5,045	4,907	4,890	4,706	4,805	7	33,690	− 1,180
Central London	6,992	6,994	7,095	7,096	7,200	7,072	7,125	7,192	7	50,391	+ 1,003
City and South London	3,258	3,239	3,297	3,177	2,994	2,905	2,896	2,816	8	24,217	− 1,545
Furness	8,257	8,260	7,800	8,697	8,287	8,394	8,077	8,810	7	55,636	+ 776
Great Central	61,455	59,850	60,001	61,805	64,906	65,316	65,618	65,810	7	450,864	+ 26,688
Great Eastern	91,100	94,900	89,100	92,400	91,600	92,000	90,600	92,300	7	631,900	− 11,700
Great Northern	105,800	110,887	100,800	102,303	102,000	106,500	100,100	101,900	7	705,200	− 29,751
Great Western	201,900	197,500	198,100	200,800	204,000	204,600	202,700	208,600	7	1,433,800	+ 21,300
Hull and Barnsley	8,070	7,425	7,464	7,211	9,116	8,468	8,588	8,857	7	60,181	+ 4,340
Isle of Wight	432	440	461	434	476	405	455	496	7	3,389	+ 294
Ditto Central	499	540	585	549	595	666	604	644	7	4,196	+ 308
Lancashire and Yorkshire	95,666	95,777	93,962	93,604	96,081	98,041	97,784	97,053	7	662,031	+ 9,986
Liverpool Overhead	1,505	1,532	1,481	1,472	1,461	1,447	1,556	1,440	7	11,773	− 444
London, Brighton, and South Coast	49,611	50,993	49,095	49,831	48,562	53,649	49,690	49,960	7	358,658	+ 7,498
London and North-Western	261,000	242,000	244,000	250,000	250,000	248,000	249,000	251,000	7	1,704,000	− 34,000
London and South-Western	78,800	70,700	73,000	75,600	79,100	74,900	76,400	79,700	7	532,500	+ 13,400
London, Tilbury, and Southend	7,214	6,799	7,263	6,974	7,494	7,043	7,705	7,315	7	52,254	+ 2,097
Maryport and Carlisle	1,948	1,980	1,867	1,919	2,125	2,218	2,069	2,068	7	14,619	+ 1,087
Mersey	1,469	1,470	1,461	1,471	1,585	1,596	1,577	1,625	7	11,309	+ 818
Metropolitan	16,826	16,776	16,795	16,641	16,880	16,692	16,696	16,796	7	119,192	+ 304
Ditto District	7,890	7,951	7,939	7,922	7,466	7,369	7,624	8,114	7	53,671	− 2,550
Midland	208,291	207,061	205,808	208,213	213,548	216,865	207,814	211,288	7	1,458,313	+ 20,498
North-Eastern	161,500	164,267	157,089	158,687	158,943	165,077	164,053	162,582	7	1,074,447	− 19,547
North London	10,222	9,619	9,560	9,673	9,547	8,989	8,838	8,794	7	64,537	− 5,531
North Staffordshire	17,589	18,128	16,625	16,962	16,348	17,180	17,345	17,664	7	115,758	− 4,974
South-Eastern and Chatham	69,419	80,367	72,593	73,608	71,005	81,113	73,739	73,911	7	528,355	+ 6,141
Taff Vale and Penarth	18,860	19,191	18,409	18,321	19,172	18,267	19,435	18,832	7	128,560	− 2,284
Caledonian	80,064	69,600	75,070	76,058	81,362	72,319	76,456	77,979	3	226,754	+ 6,026
Glasgow and South-Western	28,065	28,228	29,398	29,951	27,549	28,357	29,558	30,019	3	87,329	+ 352
Glasgow District Subway	1,403	908	1,418	1,423	1,375	922	1,376	1,429	3	4,726	− 24
Great North of Scotland	8,609	7,490	7,660	8,118	7,859	7,617	7,860	8,004	3	23,481	+ 213
Highland	7,775	8,470	8,362	8,488	7,211	8,250	8,143	8,058	3	24,451	− 869
North British	80,271	77,273	79,809	79,280	82,350	80,801	81,609	81,853	8	244,263	+ 7,901
Belfast and County Down	2,180	2,104	2,316	2,217	2,207	2,193	2,361	2,511	7	15,500	− 565
Cork and Bandon	1,342	1,373	1,446	1,248	1,357	1,353	1,350	1,412	7	9,079	− 990
Dublin, Wicklow, and Wexford	4,682	5,187	4,149	3,823	4,459	5,629	4,440	4,275	7	32,332	+ 1,697
Great Northern of Ireland	15,182	15,012	15,524	15,871	14,779	15,041	15,585	16,048	7	106,666	− 1,751
Great Southern and Western	21,644	22,429	22,149	21,632	20,800	21,511	21,378	21,851	7	147,433	− 3,557
Midland Great Western	10,588	10,191	10,179	8,947	10,009	10,160	8,812	9,320	7	65,145	− 5,631

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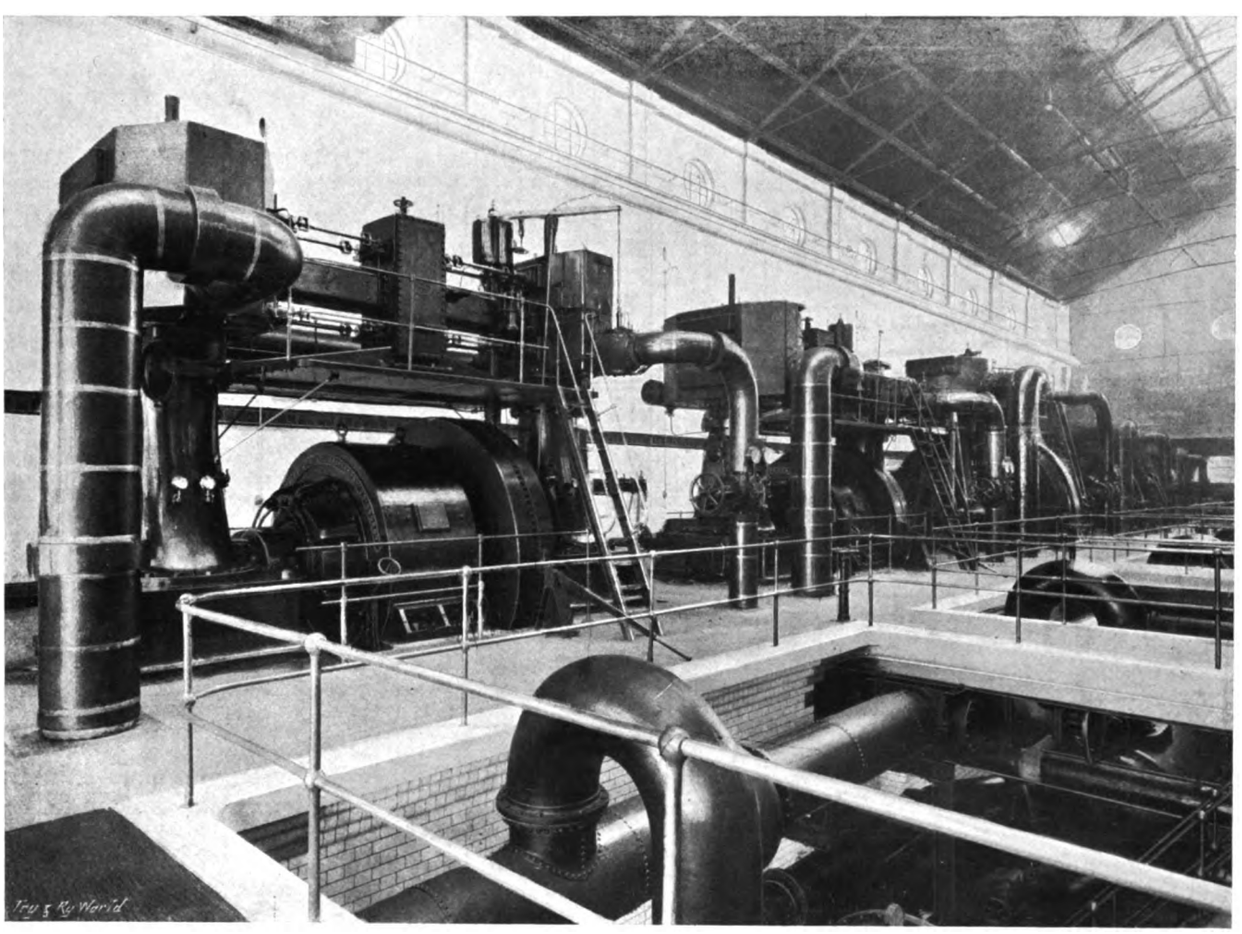
THE Tramway & Railway World
A REVIEW OF CURRENT PROGRESS IN ELECTRIC AND OTHER TRACTION

VOL. XVII. LONDON, APRIL 6, 1905. VOL. XVII.

THE TRAMWAY SYSTEM OF WEST HAM.

In any part of England except in the neighbourhood of London a county-borough with a population of 300,000 or thereabouts is an important place not merely locally, but in the common knowledge of the inhabitants of the country at large. But in the vicinity of the mighty aggregation called London there are several important boroughs which to the people resident in other parts of the country are only vaguely known as "places somewhere about London." This statement may be made with truth of West Ham, which is an independent county-borough with a population of about 300,000, and an area of 4,700 acres. It is bordered on the west by the county of London. As it is a busy industrial and shipping centre, a large part of the population belong to the working classes, while on the other hand the district of the borough called Forest Gate is largely composed of the homes of the middle class, whose occupations lie in London. To the east are the boroughs and districts of East Ham, Ilford, and Barking, to the south are the docks and the Thames, and to the north the districts of Leyton and Wanstead.



Generating Units Supplying Current for Tramways—West Ham Electricity Station.

The bulk of West Ham is of very modern growth. Half a century ago its population was less than 20,000, but the original "West Hamlet" is of extreme antiquity. Here and there among the modern streets are relics of long ago, such

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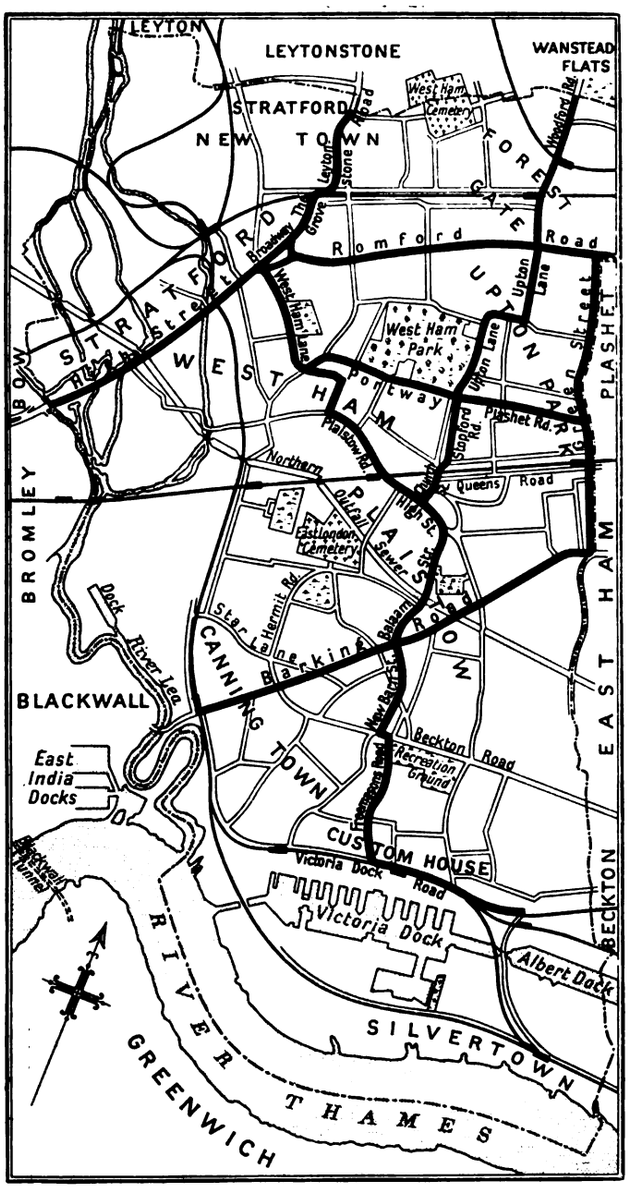
as the tower where Anne Boleyn used to reside when Henry VIII. came to visit her, and where hunting parties were organised to scour the then open country. The parish church also, a fine old building, dates back to about the fourteenth century. The public have ample space for recreation in the West Ham park and on Wanstead Flats, both of which are maintained for the general good by the Corporation of the City of London, as well as in the various recreation



Map of West Ham Tramways.

grounds maintained by the West Ham Corporation, while Epping Forest is not far away.

Nearly the whole of the country between the city of London and West Ham is now built upon, and the district is exceptionally well served by railways. There are no fewer than 15 railway stations within the borough, and on the two great main roads leading into it eastwards from London there is a frequent service of tramcars.

Under powers conferred by Acts passed in 1870 and 1884, the North Metropolitan Tramways Company laid tramways through the borough, these being part of through routes from Aldgate (London), through Whitechapel and Bow to Stratford, Leytonstone and Manor Park, and from Poplar to Greengate by Barking Road. The length of these horse lines in West Ham was about five miles. So things remained till 1898, when the West Ham Corporation got an Act passed by Parliament giving them authority to buy the tramways within the borough and to use electric traction. The construction of twelve route miles of extensions was authorised by an Act in 1900, and in 1902 and 1904 additional miscellaneous tramway powers were obtained. Mr. J. E. Waller of Messrs. Kincaid, Waller, Manville and Dawson, Westminster, was appointed consulting engineer on permanent way, and the Corporation were advised as to the electrical part of the work by Mr. J. J. Steinitz and by Mr. James K. Bock, who were successively in the post of borough electrical engineer prior to the recent appointment of Mr. W. J. W. Bullock to that office, and as to cars, depôt, office, and traffic arrangements by Mr. H. E. Blain, the tramway manager.

There was a good deal of difficulty in connection with the purchase of the North Metropolitan Company's lines in the borough, owing to the facts that they formed part of through routes, and that the Company had in West Ham large depôts used for the whole of their eastern system. After much negotiation with the Company and consultation with the Board of Trade and the London County Council, an agreement was signed in February, 1903, under which the Corporation bought at £5,000 per single-track mile the lines constructed under the Act of 1870, and at £5,500 per single-track mile the lines authorised in 1884. Two depôts were also purchased. The Company retained the horses, cars, and a granary, and they agreed to work, pending the conversion to electric traction, the lines which were being purchased. This operation by the Company is still going on, but will shortly come to a conclusion. The Corporation take the net receipts after paying the Company for carrying on the operation. The new north and south lines were first taken in hand. The first of the electric lines was opened for traffic on February 27, 1904, and since then the electric system has gradually been extended, till at present there are 9 miles 6 furlongs, route length, in operation, and 3 miles 3 furlongs of horse lines are under reconstruction. The latter will be ready for working by electricity within a few months. A further short length of authorised lines will not be built in the meantime.

Among the interesting points arising out of the installation work was the well-known West Ham arbitration decision in reference to gas and water pipes. When the work on the tracks was about to be commenced, the West Ham Gas Company and the East London Waterworks Company claimed that the Corporation were bound to carry out extensive alterations on the

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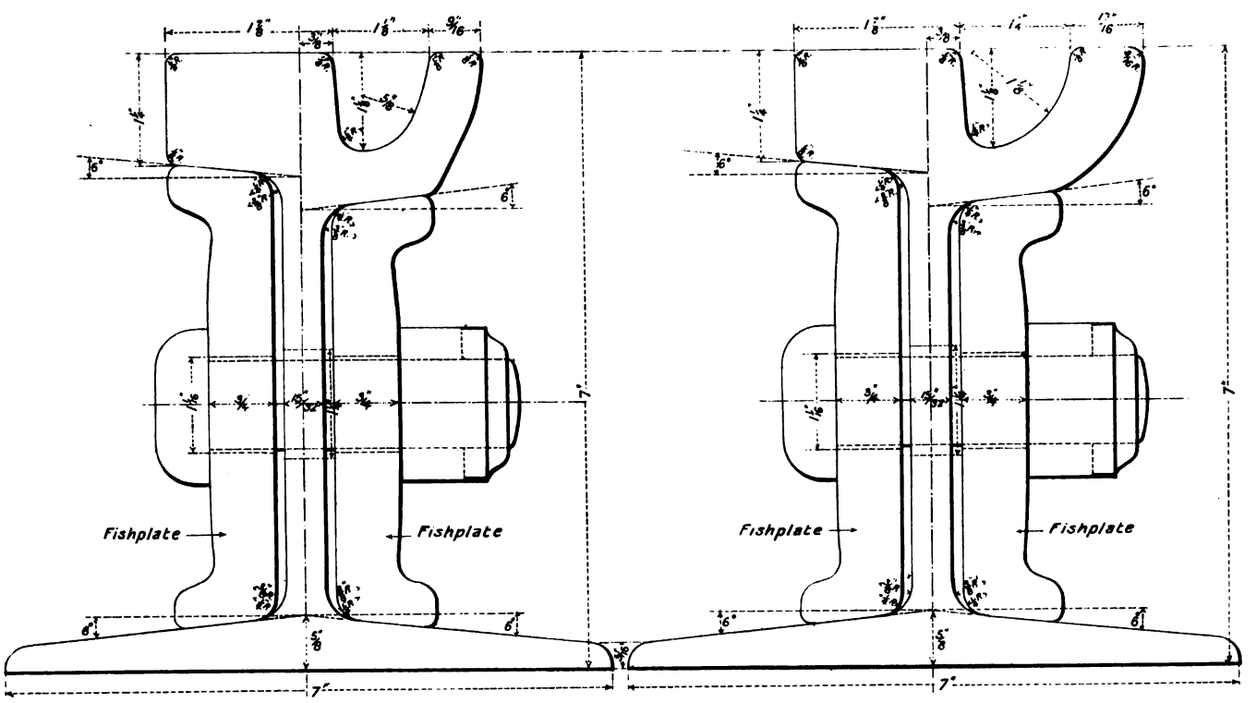
gas and water pipes so that the pipes might not be under the tramways. In reference to some places, the Companies wished the Corporation to bear the expense of duplicating the mains, so that service pipes might be taken from the mains without crossing under the tramway tracks. The Corporation resisted, and the Board of Trade appointed the Hon. Alfred Lyttelton, K.C., M.P., as arbitrator to settle the matter. After hearing parties and witnesses, the arbitrator decided in favour of the Corporation, thus saving them a large sum of money, and incidentally saving other tramway authorities still greater sums which they would, no doubt, have to pay had the decision gone the other way.

ROUTES AND PERMANENT WAY.

The general arrangement of the tramway routes may be gathered from the accompanying map. It will be seen that the greater length of the borough is from north to south, and that the west and east lines from London on to East Ham, Ilford, and Barking pass through the centre of it. The total route length of the lines is 13 miles 1 furlong, of which 9 miles 6 furlongs are now worked electrically, and 3 miles 3 furlongs of horse lines are under reconstruction. The length of double track open is 7 miles 2 furlongs, while including the part under construction there is a total double track length of 10 miles 5 furlongs. The remaining 2 miles 4 furlongs, all of which is open, is single track. The total length of the lines measured as single track is 23 miles 6 furlongs, of which 17 miles is now open. The whole district is very flat, so that there are practically no natural gradients, but at six places where the roads pass over railways and at three places where they cross sewer embankments there are short inclines, the steepest being 1 in 20 for a distance of about 20 yards. Curves are fairly numerous, and the radius of the sharpest is 40 ft. Though the main thoroughfares as a rule are of good width, some of the roads are narrow, the minimum breadth where tramways are laid being 15 ft. 4 in. The near rail is less than 9 ft. 6 in. from the footpath kerb in a considerable number of places. Only one railway bridge is passed under by the tramways, and there the height of the trolley wires is 16 ft. 9 in.

The contractor for the permanent way construction of the new lines was Mr. Fred. Osman, Southampton, while the reconstruction of the old horse tracks is being carried out by the Works Department of the Corporation. The foundation consists of Portland cement 6 to 1 concrete, 6 in. thick, the cement being supplied by the Associated Portland Cement Company.



Cross Section of Straight Rail. Cross Section of Rail for Curves.

Granite setts, 6 in. deep, are mostly used for paving, these being bedded on a thin layer of fine concrete and grouted with cement. In a few places 4 in. wood paving blocks have been employed, some grouted with cement and pitch, and some with pitch only. The rails are laid direct on the foundation to standard gauge. They weigh 100 lb. per yard, and their section is shown in the accompanying drawings. The dimensions are: Length, 45 ft.; depth, 7 in.; width of base, 7 in.; width of head, $3\frac{9}{16}$ in.; width of groove, $1\frac{1}{8}$ in.; depth of groove, $1\frac{1}{8}$ in. The composition is: Carbon, ·4 to ·55 per cent.; phosphorus, silicon, and sulphur, each not exceeding ·07 per cent.; manganese, under 1 per cent. They are drilled with $\frac{7}{8}$ in. holes for bonding. The rails for the new lines were made by Walter Scott, Limited, while those for the reconstructed tracks came from the shops of the North Eastern Steel Company, through P. and

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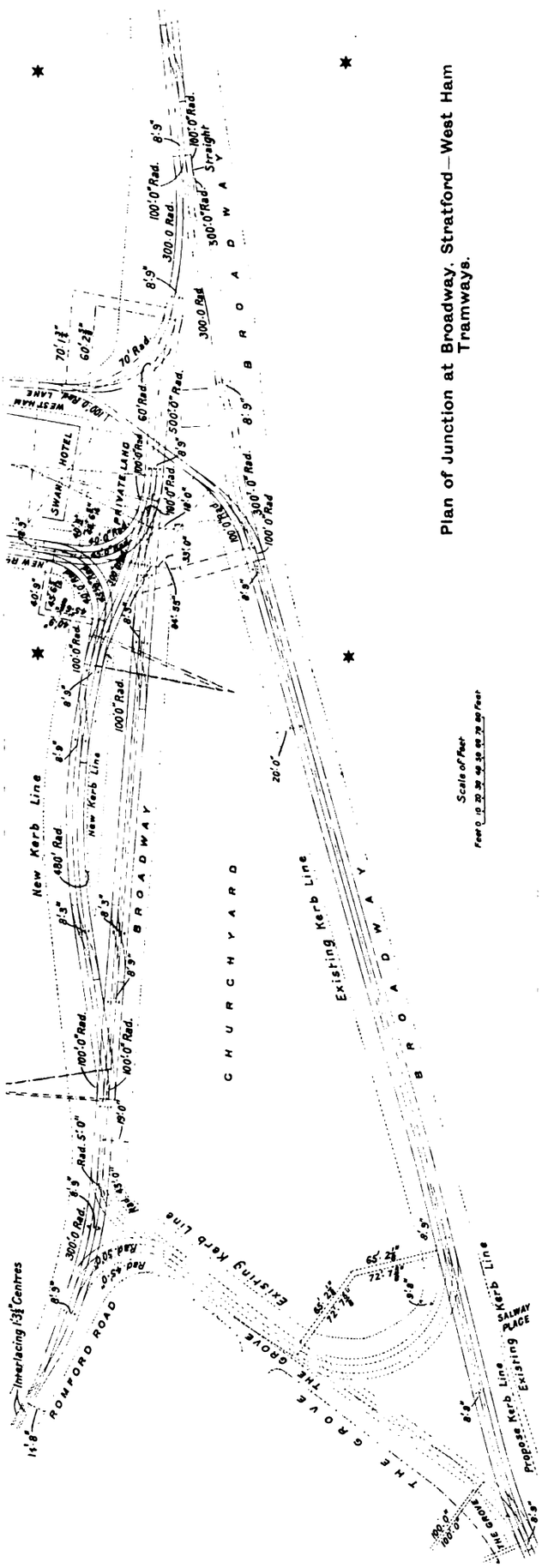
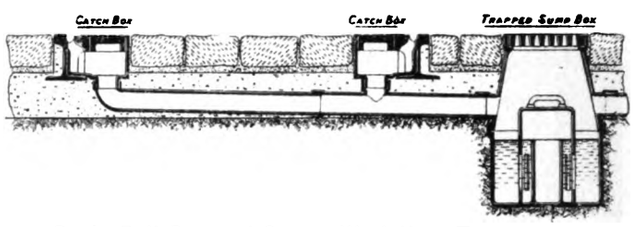


W. Maclellan, Limited. The mild steel fish-plates weigh 54 lb. per pair, and are 24 in. long by ¾ in. thick. They are secured at each joint by six 1 in. bolts with Ibbotson's patent lock-nuts. The holes are circular in one plate and elliptical in the other, so as to fit the elliptical neck of the bolt and thus prevent turning. The tie-bars are of wrought iron, approximately six of



Drain Rail Box and Sump—West Ham Tramways.

them being used for every 45 ft. length of rail. They are 2¼ in. broad by ⅜ in. thick, and are notched at one end and screwed at the other. Drain rail boxes, supplied by the Railway and General Engineering Company, are connected to cast iron sumps which in their turn are connected to the drains. The points and special work were supplied by Edgar Allen and Company, Limited. The cost of construction per mile of single track has worked out at £5,798.

There is one piece of this special work which is now being installed and which is worthy of special notice, as it is believed to be the largest piece of special work in the country. It is situated at the main terminus or tramway centre of the system in Stratford Broadway near to the Town Hall. The street here is very wide, and the available breadth has been increased to 80 ft. (exclusive of the foot pavements) by the Corporation having acquired at considerable expense a number of fore-courts of shops and thrown them into the roadway. In addition to the main tramway tracks of the through routes east and west, sidings are being provided for cars coming from and going to other routes. These cars will make these sidings their terminus. Between the sidings and the main line an island platform with a shelter for passengers and a cash office is to be constructed. In connection with this terminus, a new road from Stratford Broadway into West Ham Lane is being opened out, and a new cross track is being laid between West Ham Lane and Leytonstone Road. The total length of the special work involved is about 760 ft. It is believed that in the course of four or five years this place will become the leading centre of tramway traffic in the eastern outskirts of London. The main tramway route from Aldgate passes through it, and even at present there is a very large traffic.

The arrangement and magnitude of this piece of special work may be gathered from the drawing. The right hand portion indicated by asterisks was laid down as a complete whole at Messrs. Allen's works, and was then taken apart for despatch.

Eight installations of Turner's patent automatic point controller are being fixed by S.

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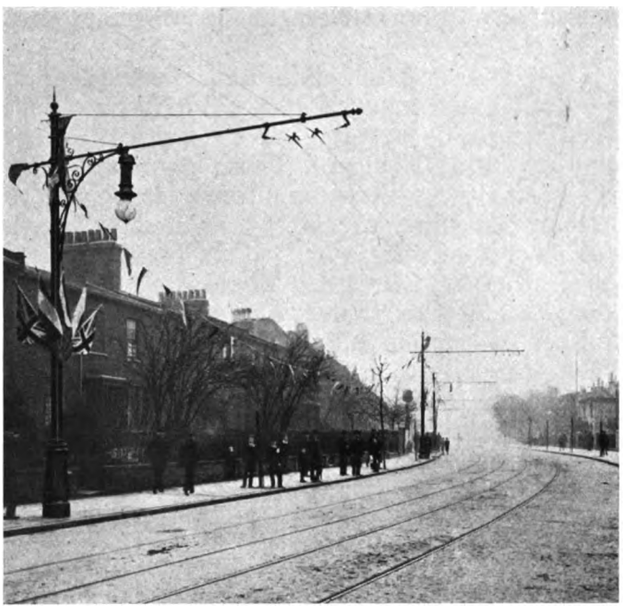
Dixon and Son, Limited, Leeds, and they are giving great satisfaction, both because they dispense with the services of point-boys, and because they are working excellently. This apparatus has previously been described in our pages, but it may be recalled that the driver of the car sets the point as he approaches according to the route he wishes to take. A branch conductor is led from the trolley wire to a pillar-box on the footpath where the electro-magnets for working the point and frog are situated. If the car, with the controller handle on the first notch, passes the place where the branch conductor leaves the trolley wire, a circuit is completed which moves the point and frog. If the controller handle, however, is at the off position the point remains in its former and normal place. If the point is moved, it is automatically set back again by a similar circuit as the car proceeds.

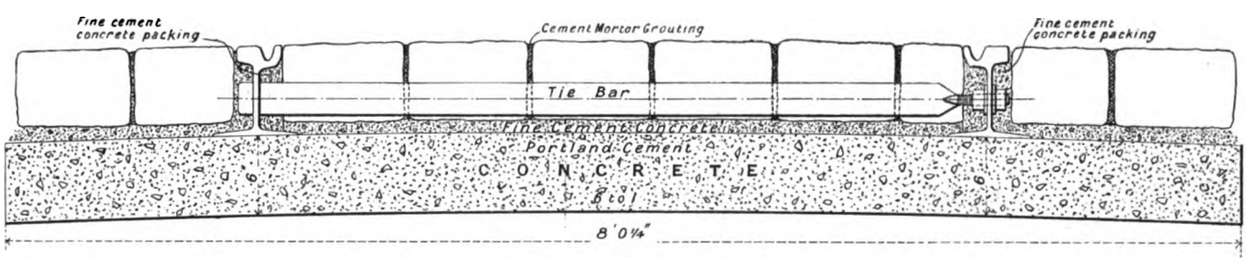
As to the bonding of the tracks, there are two crown bonds to each joint, the gauge being 0000 B. and S., and the length of bond 28 in. The total section area of the bonds at each joint is ·33 sq. in. The rails are cross-bonded every 50 yards with bonds of the same gauge as those at the joints.

arms are used, though span wire construction is employed at crossings and curves, and on wide



Side Pole Construction at West Ham.

roads. The poles are of tubular steel in three sections, 31 ft. long over all, and spaced 45 yds.



Section of Track—West Ham Tramways.

OVERHEAD EQUIPMENT AND FEEDERS.

The overhead equipment is very substantial and neat. As a rule side poles with bracket

Overhead Work at Junction

apart. They are in three weights, viz., 1,000 lb., 1,300 lb., and 1,600 lb. The brackets are of mild steel, ornamented with scroll work, and the maximum length of arm is 20 ft. The trolley wire is flexibly suspended with very heavy fittings. The swivel-headed trolley is employed, and the trolley wire, which is double throughout, is very heavy, the gauge being 0000 S.W.G. It is made of copper of 98 per cent. conductivity, and the breaking strain is 6,000 lb. It is erected in the usual half-mile sections. The insulation is that of the American Hard Rubber Company. The size of the span wires is 7/12 S.W.G., and of the guard wires (these being necessary in some places) 7/16 S.W.G. The overhead equipment was supplied by Macartney, McElroy and Company, Limited, for the first contract, and by R. W. Blackwell and Company, Limited, for the second.

In connection with the overhead equipment two sets of Harvey's automatic signalling apparatus have been installed by Messrs. Estler Brothers. These have been provided on two pieces of single track where there are curves which prevent the drivers from seeing to the next point where cars can pass. A semaphore arm is

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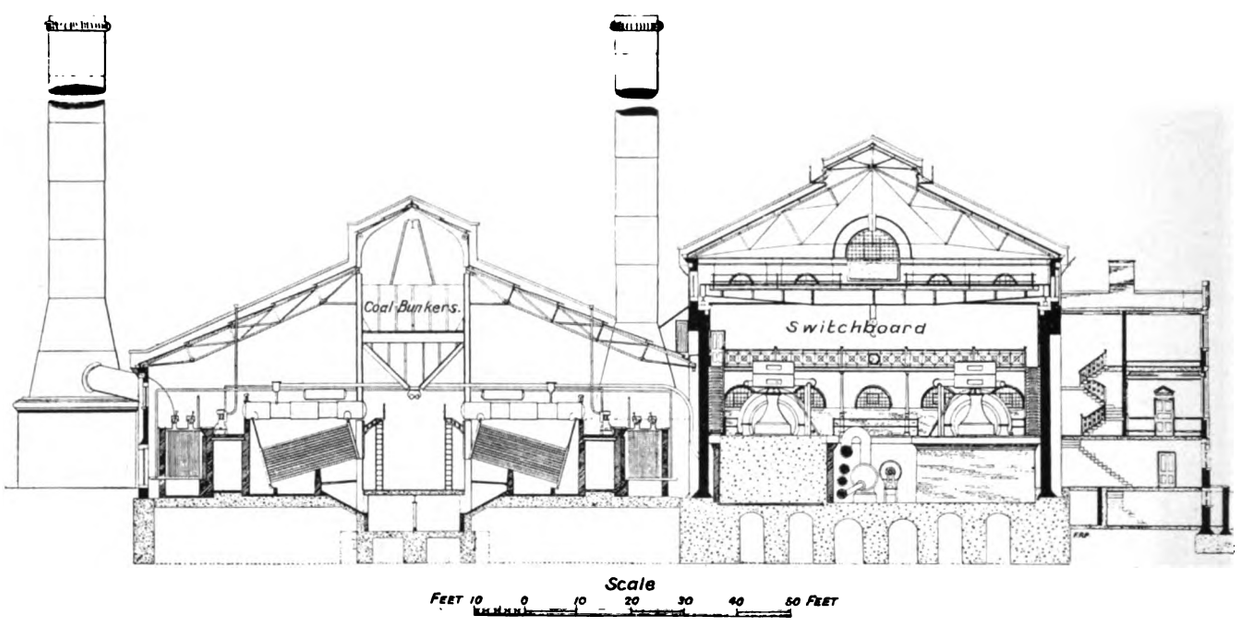
mounted on one of the poles, and it is worked by the trolley wheel of the car completing a local circuit as in the case of the point-shifter already mentioned. The apparatus is working very satisfactorily.

There is a large installation of electric feeders in West Ham in connection with the Corporation's electric lighting system, but the number for the tramways is only seven. These paper-insulated feeder cables, which are drawn into Albion earthenware pipes are of ·75, ·6, and ·4 gauge, and were made by the British Insulated and Helsby Cables, Limited. There are 18 feeding points along the routes, and there are a like number of section pillars. The distance from the power-station to the nearest feeding point is a mile and a quarter. The usual maximum drop of potential in the feeders is about 20 volts. The return feeders are four in number, three of ·75 and one of ·4. Each feeder and section box is equipped with a telephone plug contact. A portable telephone is carried on each car, and the plug is got at for making the connection by opening a small door in the upper panel of the box.



Cross Section of West Ham Electricity Station.

THE POWER-STATION.

The power-station is a large and handsome building situated on a portion of the Corporation's depôt at Canning Town on the banks of the River Lea, so that there are good facilities for the delivery of coal and materials. It occupies the site of an old sewage pumping station, and part of the former settling tanks are now used as cooling ponds for condensing purposes. This station superseded an old one which had been in use for electric lighting since 1898. The demand for current increased rapidly, and when the Corporation decided to begin working tramways, an entirely new generating station was resolved upon. The plans for it were prepared by Mr. J. G. Morley, the borough engineer, and Mr. J. K. Bock, the borough electrical engineer at that time, got out the details for the machinery installation. The building was erected during 1902 by Messrs. Gregar and Son. A Portland cement concrete foundation was put down, and a fine brick building shown in some of the drawings was erected. The engine room and boiler house combined measure 185 ft. long by 173 ft. 6 in. broad, and the height is 70 ft. The roof of the engine room is formed of steel principals boarded over and slated, and is lighted by a lantern 18 ft. wide over the whole length. The boiler house has a patent glazed roof. There are two steel chimneys lined with fire brick 125 ft. high. One is 9 ft. 6 in. in internal diameter, and the other 7 ft. 6 in.

The boiler room is 170 ft. long by 108 ft. wide, and is equipped with 17 Babcock and Wilcox water tube boilers. Each has a heating surface of 4,896 sq. ft., and is capable of evaporating 15,000 lbs. of water per hour. Coal is delivered in barges and is taken up to overhead bunkers by means of a conveyor made by the Timperley Transporter Company. The bunkers hold 1,200 tons. Skips are employed for lifting the coal, about 25 cwt at a time. Thirteen of the boilers are hand-fired, and the remaining four are fitted with chain grate stokers.

Babcock and Wilcox superheaters and four Green's economisers of 480 tubes each are employed. The feed water pumps are of Hall's and Weir's makes, and as separators, trapped water pockets on the header and mains are used. The steam piping is arranged on the bye-pass system. Each engine is coupled to two boilers and also to the main steam header. The water, steam, and exhaust piping was supplied by the Sir Hiram Maxim Electric and Engineering Company. The condensers are placed in a central pit in the engine house and are equipped

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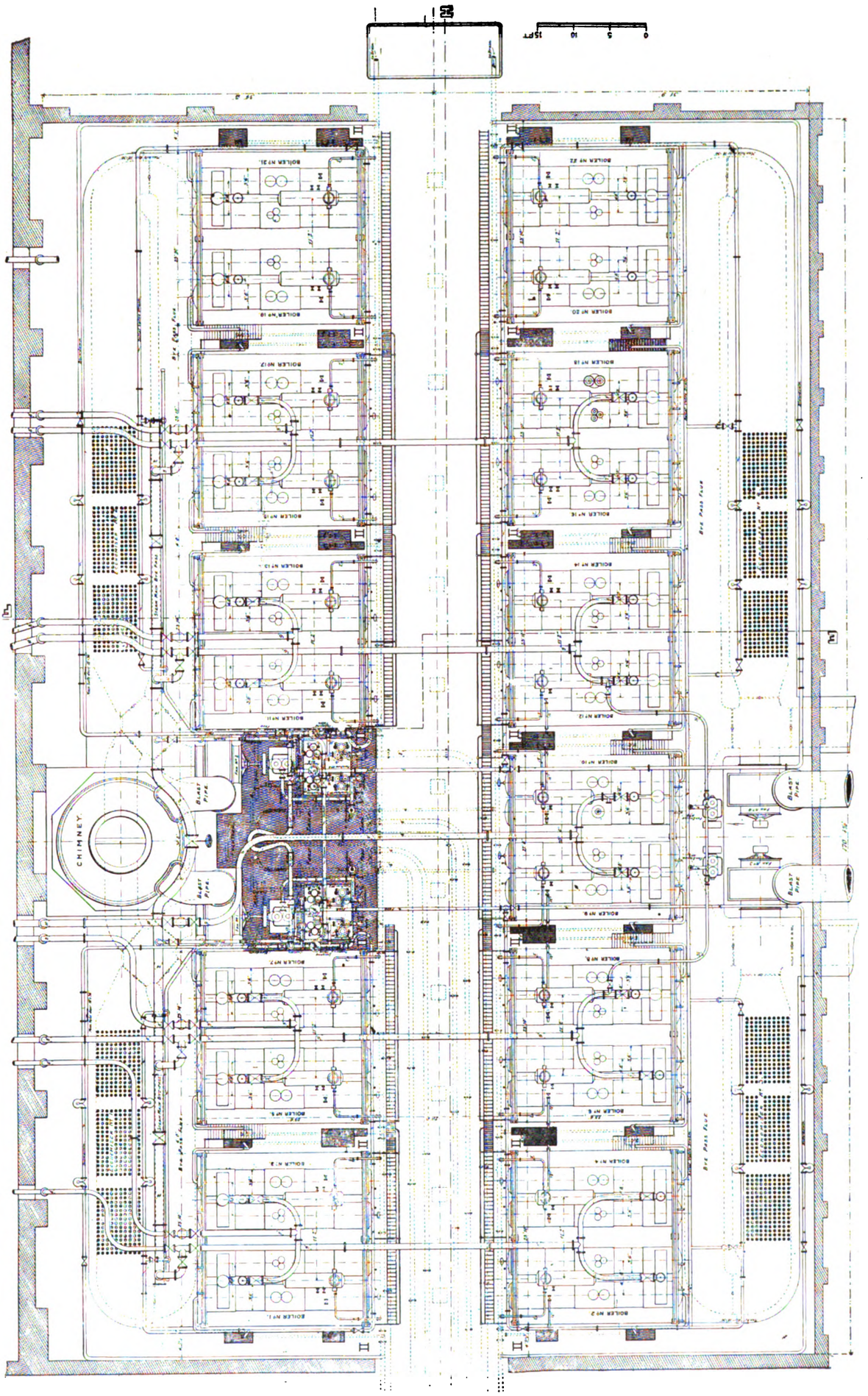

Plan of West Ham Electricity Station Boiler House.

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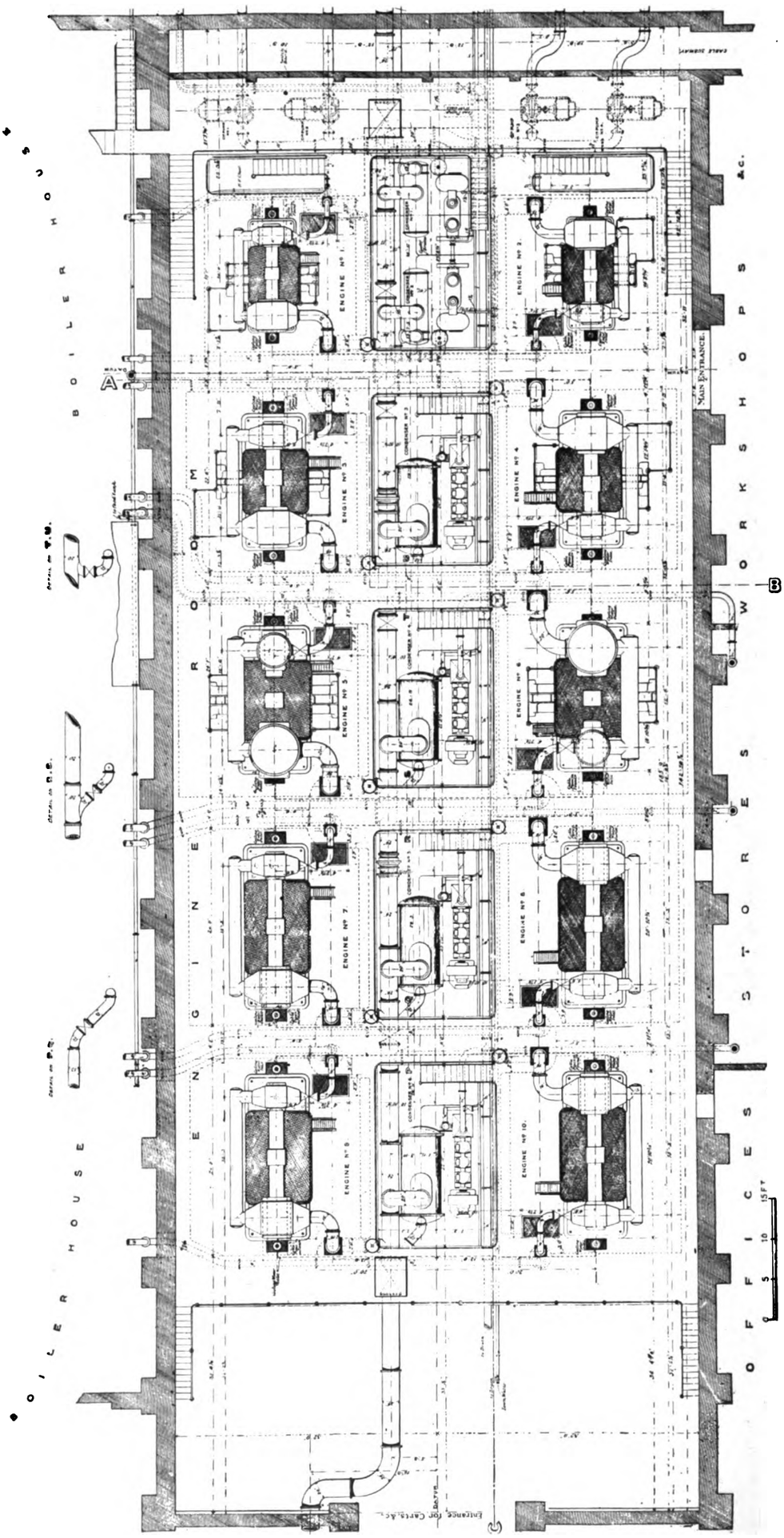

Plan of West Ham Electricity Works Engine House.

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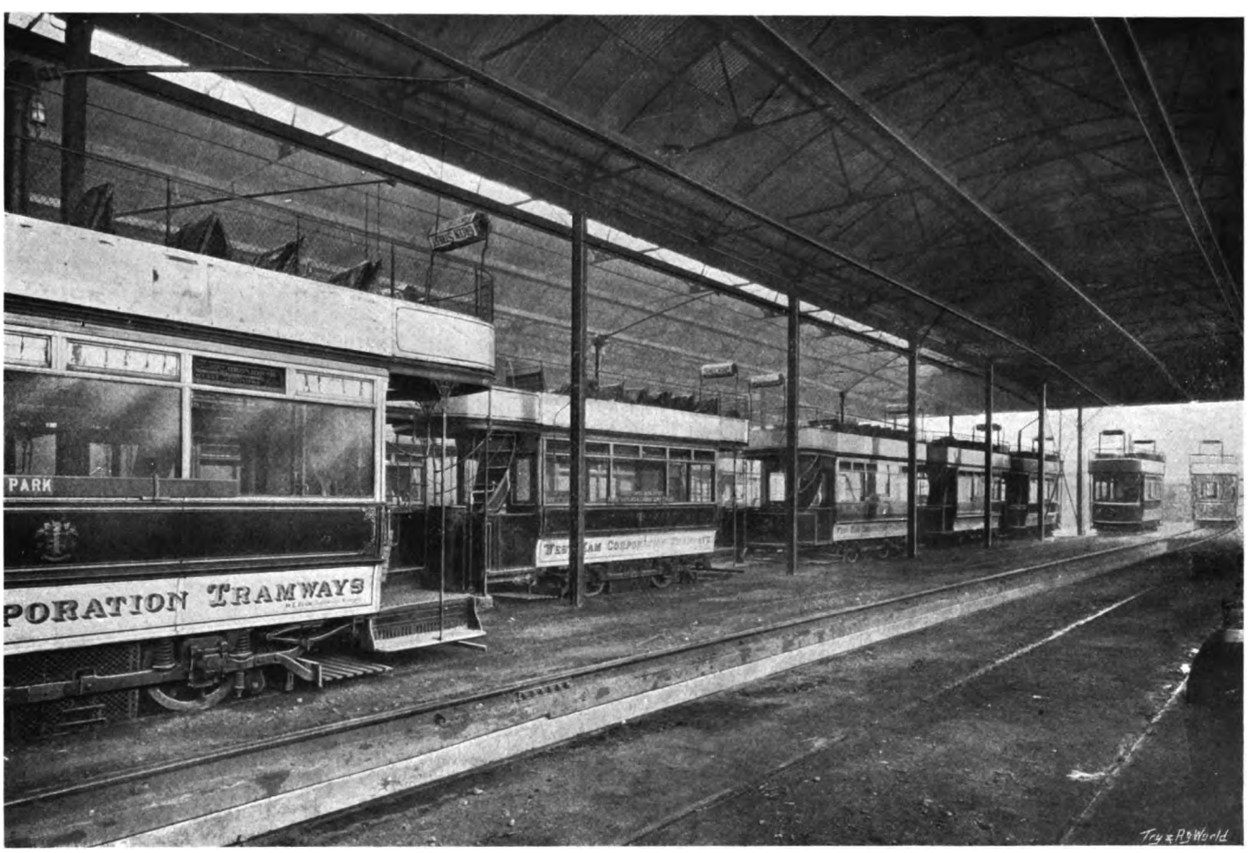
with Edwards' air pumps and with centrifugal circulating pumps. Water is obtained from an artesian well, while the public supply mains are available when necessary. The well, however, can yield 10,000 gallons per hour. The water for the condensers is obtained from the river.

The engine room is 185 ft. long by 65 ft. 6in. broad, and is very spacious and well lighted. It contains nine main generating sets arranged in two rows. All the engines were manufactured by Ferranti, Limited, and are of the cross-compound vertical type. Six of these engines are for electric lighting purposes, two of them being of 2,000 H.P. each, two of 1,000 H.P. each, and two of 500 H.P. each. They drive Ferranti single-phase alternators producing current at 2,000 volts 50 cycles per second, which is sent out to transformer sub-stations before being employed for lighting.

The remaining three generating sets are for tramway purposes only. Each Ferranti engine is of 1,000 I.H.P., running at 180 revolutions per minute. The cylinders are 22 in. and 40 in. in diameter respectively, with a stroke of 21 in. A throttle governor is employed, and the steam pressure is 145 lb. per square inch. The engines are direct coupled to the generators, and the combined efficiency is 85 per cent. The dynamos were built by Bruce Peebles and Company, Limited, and are 8-pole continuous-current compound-wound machines. The pressure is 550 volts, and the output 550 KW.

The traction switchboard was supplied by the British Thomson-Houston Company, and comprises three machine panels and one spare, eight feeder panels, one works panel, one negative booster panel, one reversible booster panel, one battery panel, and one Board of Trade panel. The instruments include British Thomson-Houston circuit breakers and wattmeters and Weston voltmeters and ammeters. The negative booster is of the British Thomson-Houston make, and the reversible booster is by the Lancashire Dynamo and Motor Company. In connection with the reversible booster there is a battery of 260 Tudor cells, having a capacity of 800 ampere hours. This is mainly used for the lighting circuits.



Interior of Car Shed—West Ham Tramways.

The engine room is fitted with a 30-ton travelling crane of 66 ft. span, made by Carrick and Ritchie.

The coal employed is Welsh nuts at 14s. 9d. per ton, and slack at 13s. The water evaporated per lb. of coal is 8½ lbs., and the coal consumption per B.H.P. hour is 3½ lbs.

ROLLING STOCK.

The number of cars which have been already supplied is fifty. These were obtained under a contract with Witting, Eborall, and Company, Limited, while as sub-contractors the British Thomson Houston Company supplied the controllers, the Brush Electrical Engineering Company the trucks, and G. F. Milnes and Company the bodies. The cars are of the usual

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double-deck, single-truck type, and each weighs complete from 8 to 8½ tons. The length overall is 27 ft. 8 in., the length over the body 16 ft., the width over all 7 ft., the width at the side pillars 6 ft. 9 in., the height from the floor centre to the ceiling 6 ft. 9 in., and the height from the rail to the under side of the floor 2 ft. 2¾ in. Each car seats 34 passengers outside, and 22 inside.

The staircases are of the Milnes type, with overhead canopy, which claims to give the advantages, without the disadvantages, of the reversed staircase. The seats on the canopy are arranged round the end of the deck, so as to provide a roomy landing for passengers and also an additional seat. The trucks are of the Brush standard single No. 1080 make, and the wheel-base is 6 ft. 6 in.; the wheels, which are 32 in. in diameter and are mounted on 3¾ in. axles, have wrought iron centres and steel tyres, and were made by the Patent Shaft and Axletree Company and A. Baker and Company. The distances between springs, centre to centre, are: Inside spiral springs, 4 ft. 8 in.; outside spiral springs, 8 ft. 4 in.; elliptical springs, 11 ft. 8 in. Hand and electric brakes are fitted, the former being of the Brush type with cross-way shaft, crank lever and chain and patent ratchet hand lever, while the other is the British Thomson Houston rheostatic brake. Angle iron collision fenders, Tidswell life-guards, and punch and lever sand boxes are provided. The number of lights per car is 15, and the upper deck is illuminated as well as the destination indicators, which are of hexagonal barrel pattern. One car has been fitted recently with Philipson's movable step and life-guard, which are giving satisfaction.

This life-guard is of a specially sensitive trigger type, but instead of a fixed front tray, a tray formed of 15 spades of spring steel, tipped with Balata belting, is used. Each spade applies itself to the track, no matter how uneven the latter may be, thereby making it practically impossible for the guard to rise over an object.

A sideguard is provided on the opposite side of the car to the step, to prevent a child getting under the platform of the car without actuating the trays. The gates or feelers are made in two parts (the one under the step is hinged to the main gate, forming one complete gate, so as to allow complete freedom for any object to pass through), and they are also made to have a free backward movement which allows them to ride very near the ground without being broken off by the oscillation of the car when going backwards. The Philipson safety step is designed to act automatically, and to prevent making a gap by the folding up of the step. If an object too large to pass under the step falls in front of the car, it raises the step with a pressure of less than three pounds, and thus passes through without injury on to the trays. This being done the step will settle quietly into position again. The force required to raise the step may be graduated by the cams and springs under the seat of the car, by which the step can be held in balance. The step may be fixed up by means of a lever and catch, as shown in the drawing on the following page, and is placed in such a position that when the driver closes the gate, the step cannot be let down, but can be used as a step whether up or down.

In regard to the electrical equipment, each car has two 25 H.P. motors of Witting, Eborall, and Company's make. These produce a pull of 1,200 lb. at the periphery of a 30 in. wheel at a speed of eight miles per hour. The maximum temperature rise at this output for one hour does not exceed 75 deg. C. The motor armatures are geared to the wheel axles by cut steel gears and pinions. The controllers are of the British Thomson-Houston B 18 form, and automatic canopy switches are provided at each end of the car. The swivelling trolleys are of Blackwell's and Estler's makes.

The Corporation have now on order 34 additional double-deck single-truck cars. The bodies are being built by the Brush Company, the electrical equipment by Dick, Kerr and Company, Limited, the trucks are of the McGuire 21 E.M. type, supplied by Messrs. Mountain and Gibson, and the wheels are by the British Griffin Company. In these new cars the wheel-base will be 6 ft. One further car is also being built fitted with Raworth's regenerative control, and will have a Brush body and a radial truck, and an order is just being placed for a combined sweeping and watering car of 2,000 gallons capacity.

Owing to the fact that the previously existing tramway depôts remain in the hands of the North Metropolitan Tramways Company until the completion of the electrification of the purchased lines, it was necessary to provide a temporary car shed. A corrugated iron building has been erected for the purpose in West Ham Lane, and as the space at disposal was limited, the various departments had to be carefully arranged and the result as worked out is very satisfactory. The building is 220 ft. long by 91 ft. wide, and has 8 tracks totalling in length about ·35 mile. There are three inspection and repair pits, and the shed can accommodate about 60 cars. The buildings connected with the shed include offices for the foreman and the night inspector, men's mess room, main work shop, smith's shop, paint shop, joiners' shop, and salt, sand, and general stores. The machines in the repair shop, which have been provided to the specification of Mr. Blain, include a car wheel press, a car wheel lathe, a screw cutting and surfacing machine, a wet and dry emery grinder, a pillar drill, an oil groove cutting machine, and a bench lathe. The joiners' shop is provided with a planing machine and a band saw, and the smithy has the usual requisite appliances. At present the various departments are on a smaller scale than they really ought to be in view of the work to be done, but matters in this respect will be put right when the Corporation's proposed new

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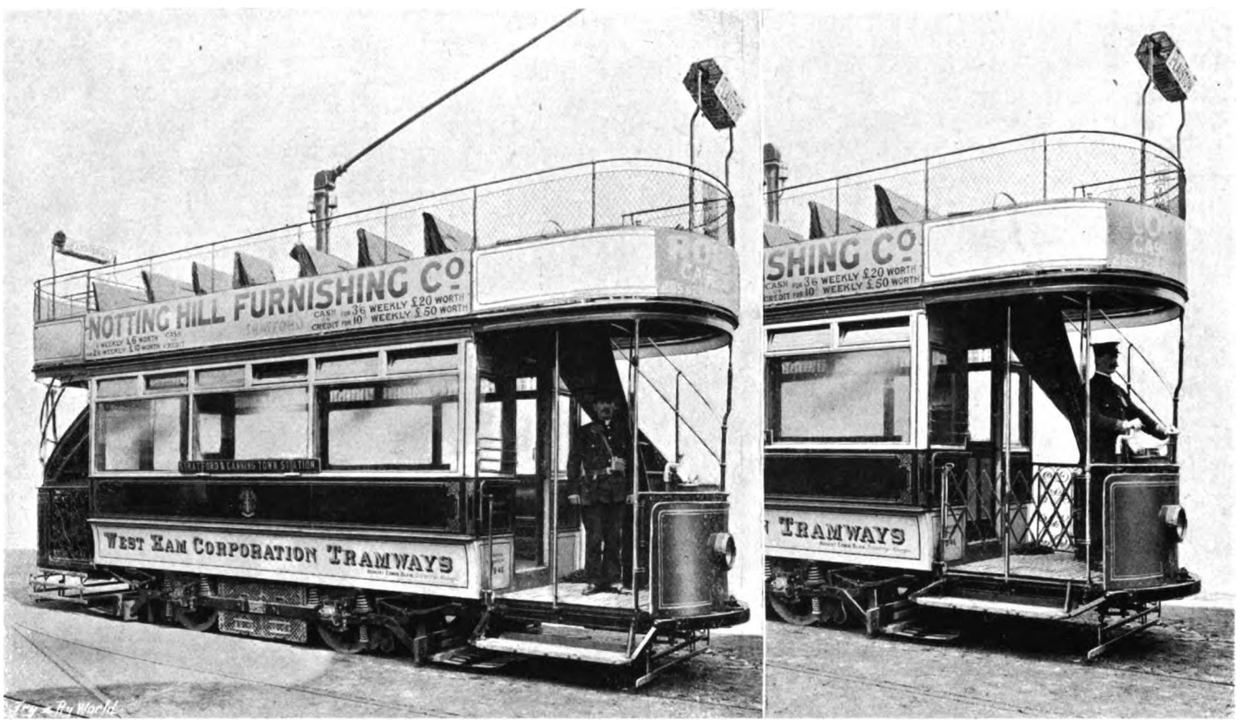
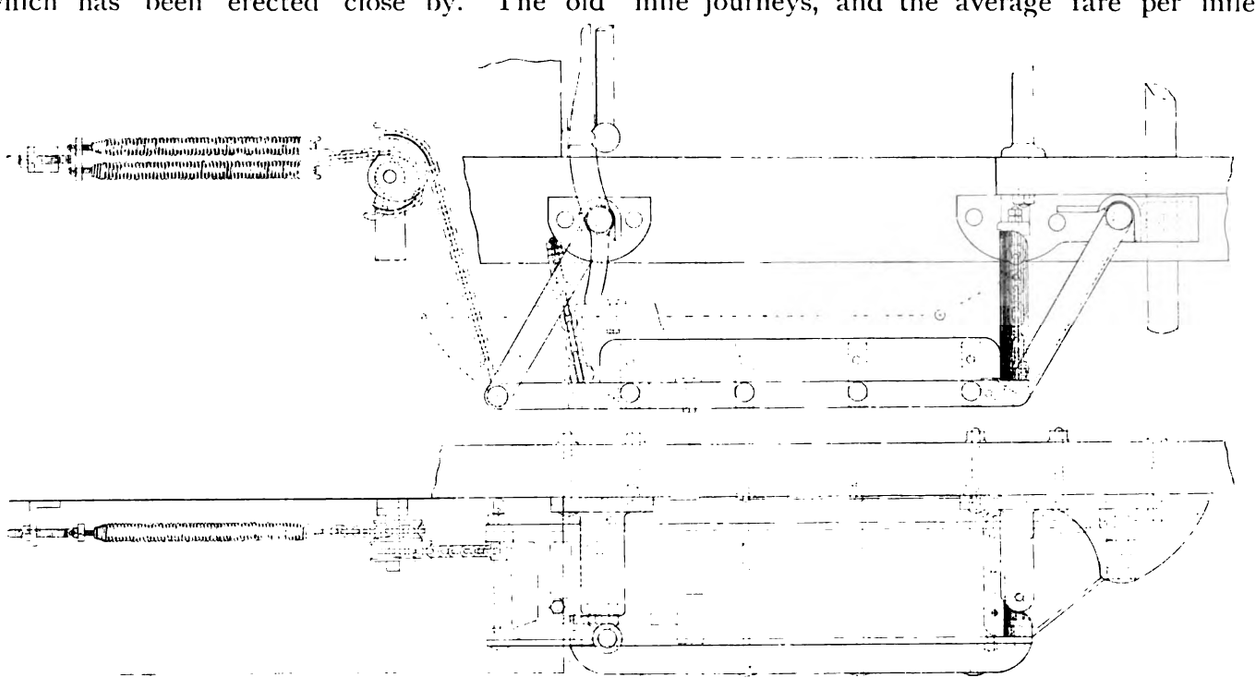
car sheds, depôt, and offices which are to be erected at Plaistow are completed.

The tramway offices at present are also of a temporary nature, and are situated close to the car shed. The building was formerly a temporary church, and it came into the possession of the tramway department on the church people migrating to a permanent building of their own which has been erected close by. The old church interior has been divided by partitions into a number of separate rooms.



Step in Normal Position. Step Raised.

West Ham Car with Philipson Step and Guard.



Elevation and Plan of Philipson Step.

TRAFFIC ARRANGEMENTS.

In regard to the traffic arrangements, the service begins at 4-50 a.m. and finishes about midnight. There are fixed stopping places at various intervals which are indicated by a new type of neat enamelled iron plates fixed to the traction poles. The average time-table speed per hour, including stops, is 6¾ miles, and the maximum speed allowed is 12 miles an hour. Halfpenny fares are in operation for half-mile journeys, and the average fare per mile is ·56d. On all cars between Stratford and the Docks between 4-50 and 7-30 a.m., return tickets are issued for 2d., the round journey being about seven miles. The return may be made on

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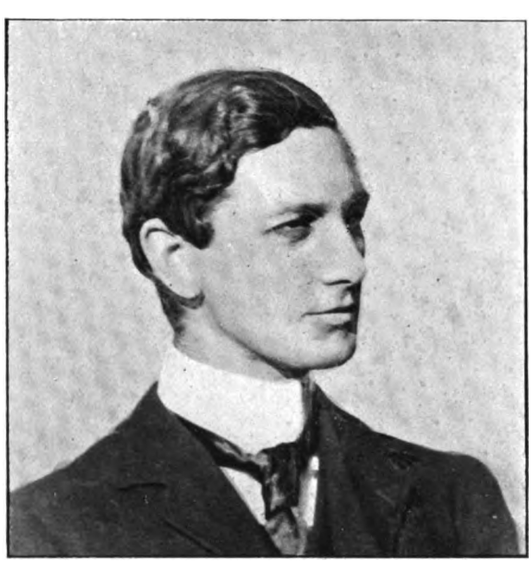
any journey on the same day. The longest through route is from Wanstead Flats to the docks, a distance of just over four miles, and the fare for this journey is 2d. The amount of current used per car mile has worked out during the first year of operation, which ended on February 27 last, at 1·037 unit. The total cost of working per car-mile was 7·08d., which includes ·43d. towards the cost of the temporary car sheds and 1·4d. as the cost of current. The wages of motor-men, conductors, and car cleaners are 7d. per hour, and the men work ten hours per day and six days per week.

In reference to the position of the men and their wages, clear and comprehensive regulations for the employees have been drawn up by Mr. Blain and the Tramways Committee, and these are working well. The minimum rate of wage, 35s. per week, is the highest minimum rate in the country. Spare men receive 2s. for attending at the depôt in the morning if they are not called upon to work. There is a very successful social and athletic club in connection with the tramways staff, which organises football, cricket, and social entertainments.

Mr. H. E. Blain,
Tramways Manager, West Ham.

With reference to through communication with surrounding districts, considerable development is anticipated in the future. At present through running is in operation between West Ham and East Ham, the through cars running from Canning Town railway station, which is the eastern boundary of the county of London, to the boundary of Barking, a distance of over three miles. An arrangement has also been made by the East Ham Council to take on lease portions of the tramways which are laid in Ilford and are being laid in Barking, and West Ham cars will participate in the through running. The present arrangement between West Ham and East Ham is described as a temporary one, but as it is working well it may become permanent. The two Councils originally could not come to an agreement, and as the matter was pressing it was remitted to the managers of the two systems to make a temporary arrangement pending the time when the two Councils could settle their differences. The advantage of this was shown by the fact that the two managers in the course of a single conference settled an agreement which has been working well for months. The through cars change conductors at the common boundary, and the fares collected in each borough, whether through or local, are retained by that borough.

It will not be possible to have through running into the heart of London till the London County Council's lines now worked by the North Metropolitan Tramways Company are electrified. When that is done no difficulty is anticipated in making an arrangement. If the London lines are on the conduit system the through cars will have to be equipped both with the conduit plough and with the overhead trolley pole. The changing from the one system to the other,



Mr. W. J. Bullock,
Borough Electrical Engineer.

Mr. W. Ivey,
Chairman, West Ham Tramways Committee.

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which is in regular operation at Bournemouth, presents little difficulty or delay. It is also hoped that cars will be run through Leyton on the north, and even up to the lines owned by the Middlesex County Council by way of Walthamstow and Tottenham.

In reference to the working arrangements and the local conditions, there are some further interesting points to be noted. Among all the tramway systems of the country which have halfpenny stages, West Ham is excelled by two only in the direction of lowness of average fare charged per mile. In Glasgow it is ·45d., and in Sheffield it is ·5d., while in West Ham it is ·56d. West Ham differs also from all other tramway systems except those in the immediate vicinity of London in the fact that it has practically none of the ordinary business traffic from 8 to 10 a.m., and between 5 and 7 p.m., which is, generally, the greatest source of tramway revenue. In West Ham, almost the whole of this traffic goes into London by train, thus reducing the hours of profitable traffic to a minimum. There is, owing to the existing low basis of fares, but an infinitesimal profit derivable from the early morning service, which, again, in other towns is an appreciable assistance to the profitable traffic. The train service to the City militates, also, against West Ham's shopping traffic in the day time, and Mr. Blain is convinced that it is not until evening, and on Saturdays and Sundays, that any appreciable profit is derivable from any route.

The following table shows the percentage of passengers carried at the various rates as compared with the respective percentage of receipts:

Rate of Fare.	Percentage of Passengers.	Percentage of Receipts.
d.		
½	40·8	23·95
1	48·6	57·05
1½	7·3	12·91
2	2·2	4·74
Workmen	1·1	1·35
	100·0	100·00

Despite the adverse conditions mentioned, the first year's working, which ended on February 27 last, has disclosed a net profit of about £8,000 after paying interest and sinking fund and carrying £3,000 to reserve. At the time of writing, the detailed accounts have not yet been published, but the number of passengers carried was upwards of 14,587,000. The miles run amounted to 1,141,886, and the total receipts were about £58,000. During a considerable part of the year only a small part of the system was open, so that, in future years, the receipts are certain to be much higher.

In connection with third party compensation claims, West Ham has adopted the form of notice stating that passengers are carried only on condition that the Corporation's liability for compensation to any one passenger is limited to £25. The compensation work is dealt with direct by the Corporation, and not through an insurance company, the town clerk and the tramways manager having full authority to deal with all claims. The tramways manager has also been empowered, by a resolution of the Council, to act for the tramways department in all police court and in the smaller county court cases. These arrangements have worked with marked success.

The whole of the working of the tramway system is under the efficient managership of Mr. H. E. Blain, who was formerly connected with the Liverpool Corporation Tramways, and who was appointed to the post in West Ham in 1903 from among 137 applicants. The borough is also well served in its tramway affairs by Mr. Alderman W. Ivey, chairman of the Electric Lighting and Tramways Committee, who has had a wide experience of tramway matters in a professional capacity, and by Mr. W. J. W. Bullock, the borough electrical engineer, whilst the Mayor (Mr. Alderman J. Byford, Junior), who is a former chairman of the Committee, takes a great interest in the work.

PONTYPRIDD ELECTRIC TRAMWAYS.

The electric tramways of the Pontypridd Urban District Council were opened for public service on March 6 last. The undertaking is of

Electric Tramways Over Bridge at Pontypridd.

considerable interest from the fact that the population served is only about 36,000, and the Council certainly deserve credit for boldness. The question whether they should embark on an electric lighting and tramway scheme was one which exercised their minds for a considerable time, and it was in the face of a considerable amount of opposition that the most public-spirited of the members of the Council carried the day, and in the opening ceremony they realised the result of their labours for the past three years.

The undertaking has not been unduly rushed, seeing that the Council obtained their Electric Lighting and their Tramways Orders Confirmation Acts in 1901 and 1902. In January, 1903,

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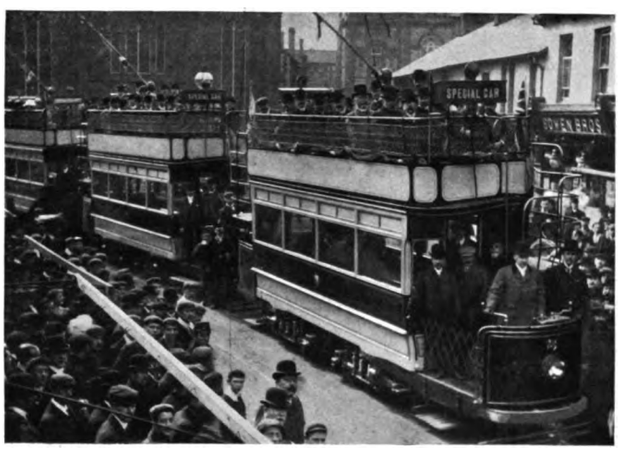
the Board of Trade held their enquiry at Pontypridd into the application of the Pontypridd Urban District Council for powers to borrow money for the above purposes. This enquiry, which was opposed by certain companies, ended in the Inspector deciding that the Council, together with their consulting engineer, Mr. R. P. Wilson, had substantiated their case and granted the application in due course.



Opening of Pontypridd Tramways.

In the same year tenders were obtained and accepted for the various works, and one or another contractor has been continually at work since.

The generating station, combined with a refuse destructor and car depôt, is situated on ground adjoining the Council's gas works at Treforest.

The tramway route is from the car shed into the Cardiff Road, crossing the Castle Bridge, up through Castle Street, to the Treforest terminus. From here it runs through Park Street, Fothergill Street, and through a private road which is known as the Old Tram Road, and enters Pontypridd almost at the entrance to the Taff Vale Railway Station. Here it turns sharp to the right, down through High Street, over the Rhondda Bridge, and through Taff Street. Turning at the end of Taff Street it passes over what is known as the new Victoria Bridge, which stands side by side with the famous Pontypridd old stone bridge, and passing through Bridge Street and over the canal, it ascends Trallwyn Hill, along Coedpenmaen Road, and up the hill to Pont-shon-Norton, where it joins the Cilfynydd Road (which is also the main county road). It follows this road to the Albion Colliery at Cilfynydd, which is the present terminus. Both curves and gradients are numerous. The radius of the sharpest curve is 30 ft., and the steepest gradient is 1 in 10.

The contractors for the whole of the track work were R. W. Blackwell and Company, Limited, who had to contend with considerable difficulties in the laying of the track owing to the narrowness of the roads in many places. On account of the narrowness of the main street, Taff Street, the Board of Trade compelled the Council to put in double lines the whole way, with some special crossings to enable the cars to travel on either line, with a view to reducing obstruction to traffic to a minimum. This additional work proved very costly to the Council, but is an undoubted gain to the town. Furthermore, the streets in the main portion of the town are considerably improved by having been wood-paved from kerb to kerb. The gauge is 3 ft. 6 in., and the rail employed weighs 95 lb. per yard. Chicago bonds are used at the joints.

The contractors for the overhead equipment were the British Insulated and Helsby Cables Company, Limited. They also had a much more difficult task with the work in Pontypridd than in many towns, and, owing to the rocky nature of the ground, in many places they had to blast the rock in making the holes for the poles. Both span wire and bracket constructions have been employed.

The whole of the underground cables have been supplied by W. T. Henley and Company, Limited. This firm again had a more difficult work in laying these cables than in many of the hundreds of towns where they have carried out contracts. The narrowness of the streets causes gas pipes, water pipes and the mains belonging to the South Wales Electrical Power Distribution Company, to be in such close proximity to one another that it is a difficult job to lay the mains in such a way as will make it possible for the respective parties to be able to get at their own

Mr. Hugh Bramwell.
Chairman, Pontypridd Tramways Committee.

Mr. J. E. Teasdel.
Borough Electrical Engineer.

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mains. Four feeder cables were laid, three of ·31 each about two miles long, and one of ·25 about one mile long. The contractors for the buildings were Messrs. Hughes and Stirling, of Bootle, Liverpool. The engines are by Messrs. Combe, Barbour, and Company, of Belfast. They are of the vertical cross-compound type, with Corliss valve gear, and are provided with the makers' patent reheaters, with which it is hoped to effect considerable economy in the working. The engines, of which there are three, viz: one of 500 H.P. and two of 200 H.P., run at 125 and 150 revs. respectively.

The dynamos are by Messrs. Greenwood and Batley, and they are arranged either for running on the lighting or traction supply as required. The switchboard for the electric lighting and traction is one of Messrs. Ferranti's well-known type. The balancers for the electric lighting system have been supplied by the British Westinghouse Electrical and Manufacturing Company, Limited. The distribution for tramway purposes is at 500 volts, and for lighting at 230 volts and 460 volts on the three-wire system.

In the boiler-house there are at present only two boilers, but these are supplemented by two more boilers in the refuse destructor house; the latter, however, are not yet fixed. The boilers were built by Babcock and Wilcox, Limited, for a working pressure of 200 lb. per square inch, and are fitted with that firm's usual type of superheater. They are also fitted with Sugden's boiler stop valve, which is a safety stop valve of the non-return type, the great feature of which is that, should a boiler tube burst, the stop valve will automatically shut off this boiler from the steam ring, and should a main steam pipe burst the stop valve will automatically shut off the boiler to which it is fitted.

The whole of the pipe work and feed pumps, together with a water softener, have been supplied and fixed by R. W. Blackwell and Company, Limited, one of the pumps being a patent of a member of their firm, Mr. Sinclair, and is of a unique design. It is a motor-driven pump, and while the motor is running at full speed, and therefore at its highest efficiency, it is easily capable of hand adjustment, which actuates double eccentrics working on the same shaft, and regulates the stroke of a three-throw pump from nil to full stroke. The pump is therefore capable of pumping from nothing to 2,000 gallons per hour, its full capacity.

The feed water softener and detartariser is one of the Boby pattern, and the economiser one of Messrs. Green's usual type.

The arc lamps, which are of Messrs. Johnson and Phillips' make, are 40 in number, are of the enclosed type, and are fixed on the top of the tramway poles.

The contractors for the cars were the British Thomson-Houston Company, Limited, who sublet the contract for bodies to the Brush Company. Six of them are of the double-deck type and six of the single-deck, all of them being fitted with bogie trucks of the Brill make, and driven by two G.E. motors, 37·5 B.H.P., and therefore capable of mounting with a full load any of the gradients at a speed of ten miles per hour if necessary. Each car is also fitted with the British Westinghouse Company's electro-magnetic track brake, which is capable of pulling a car up dead on the steepest gradient under normal conditions. The double-deck car accommodates 46 passengers and the single-deck car 32.

The total length of track at present equipped is a little over 3½ miles, and the Council are now engaged in an extension to Hafod, which will mean another 1½ miles.

The whole of the work has been carried out by the consulting engineer to the Council, Mr. R. P. Wilson, Westminster, Mr. W. S. King acting as resident engineer for him, to whom considerable credit is due for the manner in which the work has been carried out.

In November last Mr. J. S. Teasdel was appointed by the Council as resident engineer and manager, taking up his duties about the middle of December. He has since been fully engaged in organising the staff and in administrative work, so that things were all in order at the date of the opening ceremony.

The capital expenditure on the tramway undertaking is approximately £60,000, but this does not include the Rhondda section about to be constructed. The approximate expenditure on the electric lighting and generating station is £55,000.

BACTERIA IN THE NEW YORK SUBWAY.

Dr. W. H. Park, director of the research laboratory of the New York Board of Health, has made a report as to the allegation that bacteria in the New York Subway are unusually numerous and pernicious. With respect to the bacteria which are carried into the Subway in various ways, Dr. Park says there are fewer of them to be found in the dust and soil of the Subway than outside. The air in winter is drier, and the absence of moisture is always a powerful germicide. The very drying up of the material in which bacteria are found is sufficient in itself to kill from 80 to 99⅞ per cent., according to the variety and conditions apart from the drying of all the bacteria to be found therein. At Seventy-second Street he gathered about one-fiftieth of a gram of dust from the top of a girder reaching across the top, and about one-fiftieth of a gram of dust from the sidewalk on the outside. After 48 hours it was found that in the dust gathered from the Subway girder there developed in nutrient agar 240 colonies of bacteria, while from that gathered from the outside there developed 820. At Eighteenth Street a similar experiment with a similar quantity of material showed after 48 hours 650 colonies from the dust gathered from the floor of the station, as against 2,000 from that gathered from the sidewalk. At Eighteenth Street a swab was rubbed over the whole of the lower end of a frame of an advertising sign which was fixed in the wall, and at some distance above the floor, and from the material thus gathered only eight colonies developed. These and other experiments, Dr. Park declares, show conclusively that at the present time the dust in the Subway as a general proposition is freer from bacteria than that to be found outside in the streets.

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PNEUMATIC POWER HAMMERS AT LEEDS TRAMWAYS REPAIR SHOPS.

FROM A CORRESPONDENT.

Pneumatic hammers have during the last three or four years been extensively adopted in many workshops where the use of a steam hammer would necessitate a special boiler to drive the hammer alone. Especially is this the case with tramway repair shops, the motive power for the ordinary machine tools being generally obtained from the electric supply by a motor driving a line shaft. The need for an efficient power hammer has been felt by many, who looked askance at the cost of a steam boiler which might only be called upon at intervals during the day, and would need practically one man to attend to keeping up the requisite steam pressure. Many new power hammers have been offered for sale at various times, all said to be an improvement on anything hitherto on the market, and able to deal with general and special smith work as efficiently as an ordinary steam hammer. Most of these tools suffered from a multiplicity of moving parts which very rapidly showed signs of wear. Owing no doubt to the short useful life of some of these power hammers, no large numbers were sold for general smithwork until the introduction into this country of the "Yeakley" type of power hammer from the States some four years ago. Messrs. P. Pilkington, Limited, of Bamber Bridge, were one of the first to put a belt-driven power hammer on the market, built with the simplicity of a steam hammer. A large number of these have been adopted of late, the principle of working being the production of a vacuum which moves the piston and tup.

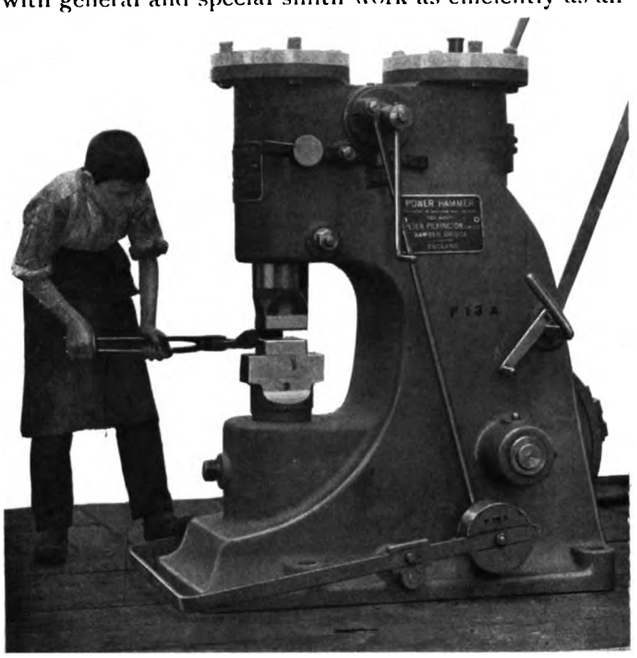
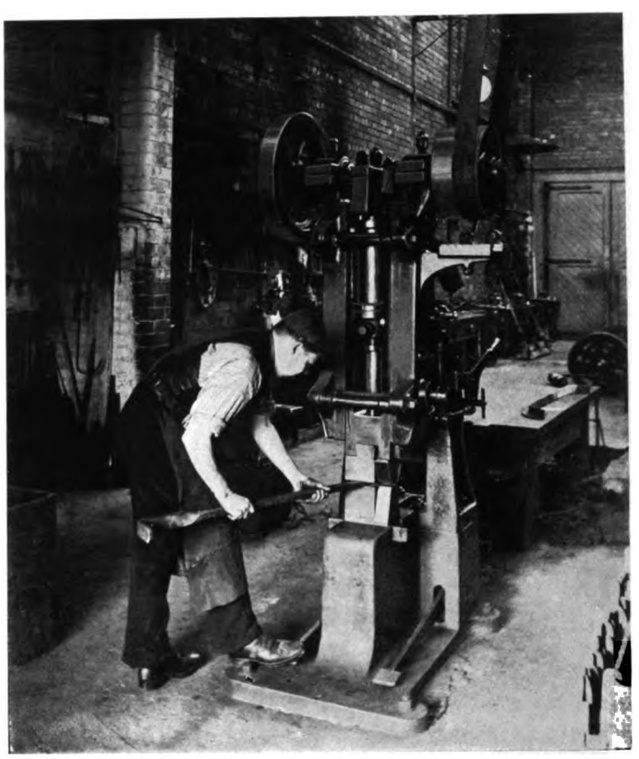


Fig. 1.



Fig, 2.

One of these hammers has recently been supplied by Messrs. Pilkington to the Leeds Corporation tramway workshop at Kirkstall Road. Fig. 1 shows the substantial appearance of this tool. It is fully under the control of the operator by means of the foot lever, which controls the valve between the hammer cylinder and the power cylinder. The hammer is belt-driven either from the workshop shafting or from a motor fixed to the frame.

The control valve is arranged to give three separate and distinct actions. The first and simplest one allows free passage between the power and hammer cylinders, the result being that on the down stroke of the power piston air is drawn from the hammer cylinder, creating a partial vacuum, the tup being then lifted by the pressure of the atmosphere; by the time the hammer tup is fairly started on its upward journey, the power piston has got to the bottom of its stroke and has returned part of the way on the up-stroke, with the result that both the power piston and the hammer tup are on the up stroke together, and consequently a very considerable compression of air takes place in the upper portions of both cylinders, and the tup is driven down with great force to strike the heaviest blow.

The next position of the valve will only permit air to pass from the hammer cylinder to the power cylinder; it is then obvious that on the down stroke of the power piston a vacuum is produced in the upper portion of the hammer cylinder, and that vacuum cannot be destroyed on the up stroke of the power piston because of the non-return valve, which prevents the return of the air to the hammer cylinder; the tup is therefore held suspended in the upper portion of the cylinder, and the anvil is left quite unobstructed.

The third position of the valve is such that air can pass only from the power cylinder into the hammer cylinder. The air is then compressed into the upper portion of the hammer cylinder, and in this manner forces the tup down towards the anvil; this forms a vice for bending, etc. Of course, intermediate positions of the valve can be used, giving varying effects between the results described in detail.

Messrs. B. and S. Massey, of Manchester, the eminent makers of steam hammers, seeing the increasing demand for a strong yet simple power hammer, and no doubt feeling the pinch of competition against their steam types, some two or three years ago designed a power hammer, actuated by compressed air, one of which will be described later.

At the Leeds Corporation tramways depôt a power hammer supplied by Messrs. Greenwood and Batley, of Leeds, has been in constant use for several years,

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and is still doing good work. Fig. 2 gives a clear idea how the smith uses the hammer. A hand lever is fixed to the side of the frame in connection with the foot lever on which the smith has his foot. This lever controls the valve by means of a sliding wedge and easily regulates the force and number of blows at the will of the operator. In fact, so sensitive is this control that practically a single blow can be struck if desired. The action of the tool is simple. It will be seen from the view that the cylinder is moved from the crank. This movement compresses air inside the cylinder and this air is regulated by means of the controlling valve previously referred to, so that any strength of blow can be obtained from the minimum to the maximum. A good point about this power hammer, and where it is undoubtedly better than several other types known to the writer, is the power of holding down a forging by

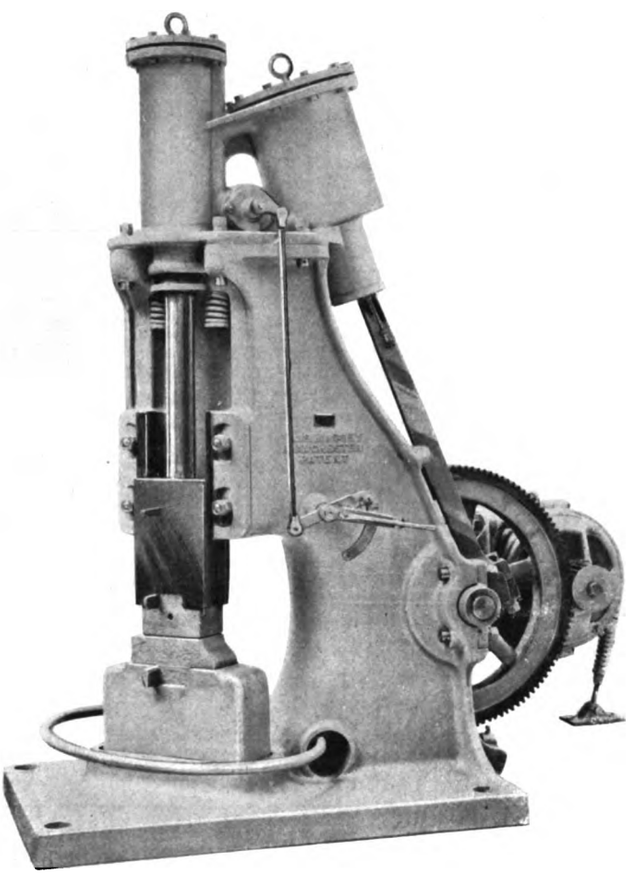

Fig. 3.

means of the tup. As every engineer knows, this is of great service to the smith when bending, etc., and the chief objection to many other power hammers is that they cannot do this. The hammer at Kirkstall Road is the 1 cwt. size, and occasionally deals with forgings 2 in. in diameter, the distance between the faces of tup and hammer block when the tup is suspended by the brake is 8½ in. The speed of the driving pulleys is about 240 revolutions per minute, the power being taken direct from the line shaft, which is run by an electric motor.

Fig. 3 shows a 1 cwt. power hammer supplied in 1903 by Messrs. B. and S. Massey, Manchester, to the Leeds Corporation tramways department. This hammer is in use at the permanent way shops, Wellington Road, and is said to give complete satisfaction. As will be seen it has a hand lever and foot treadle control similar to the hammer at Kirkstall Road, and although Messrs. Massey's tool apparently looks more complicated, it in reality is a simpler one. The section Fig. 4 shows the method of working. The hammer head, piston, and piston rod are actuated by compressed air at 40 to 50 lb. pressure per square inch, precisely in the same manner as if steam was the power

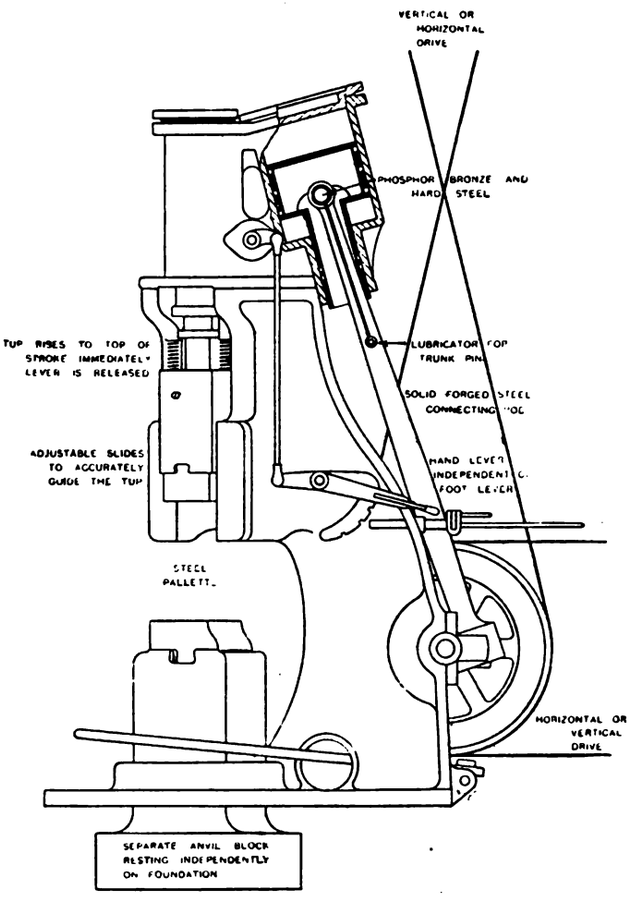

Fig. 4.

employed. The compressed air is supplied from the rear cylinder, this being of larger diameter than the front one: the air is regulated by means of an exceedingly ingenious controlling valve. This valve is worked by the hand and foot levers shown, and can be adjusted by a series of four catches to as many positions, or

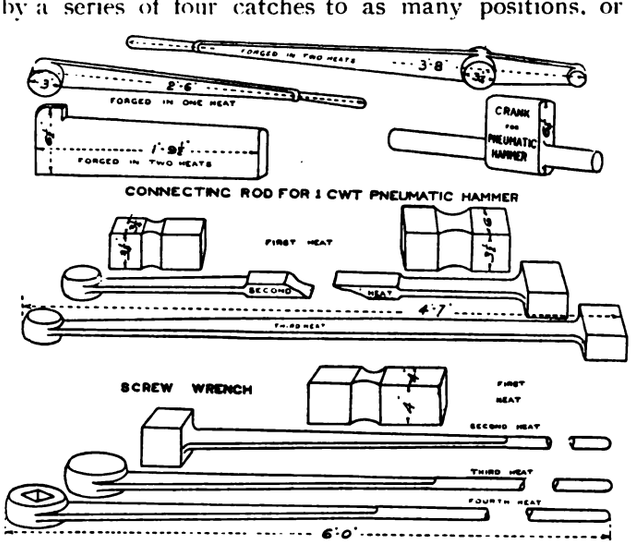

Fig. 5.

held in any intermediate position. The upper or No. 1 position holds the tup at the top of its stroke. No. 2 allows the air cylinder to keep in operation without affecting the hammer cylinder. No. 3 position gives the maximum blow, and by adjusting between No.

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2 and 3 positions, any strength of blow can be obtained. The No. 4 position presses the hammer head down

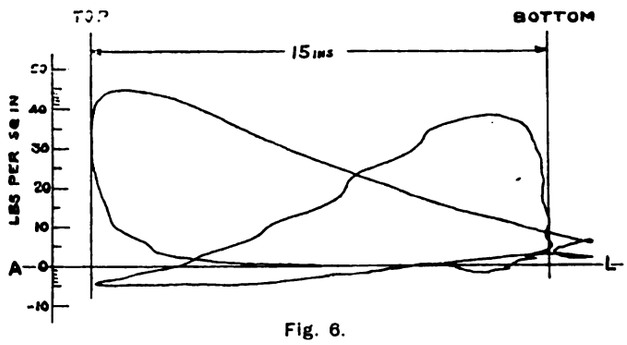

Fig. 6.

upon the anvil, thus allowing the smith to use the tool as a vice for bending, etc. By the courtesy of Messrs. Massey, an indicator diagram is given in Fig. 7, which proves that the compressed air is used expansively, and therefore economically. Besides that, the moderate

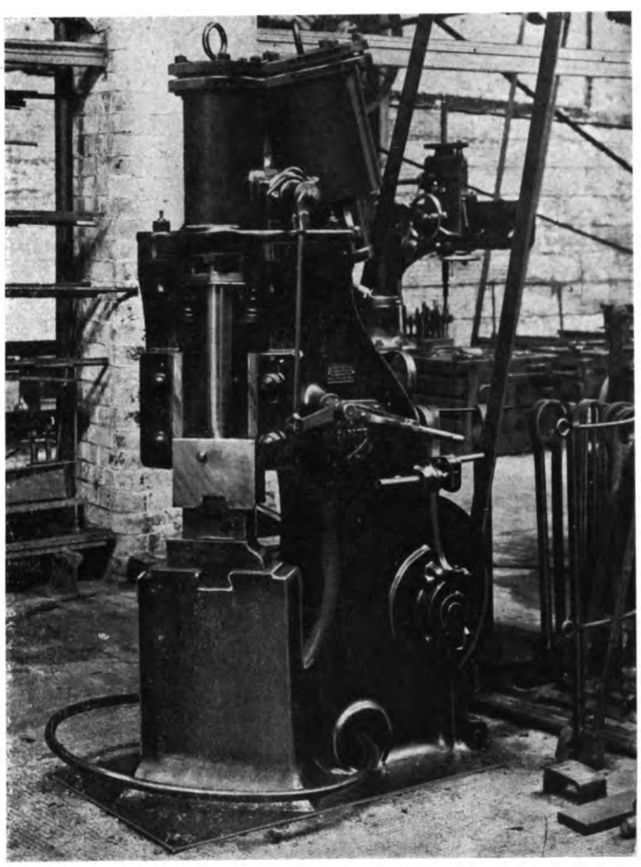

Fig. 7.

pressure used, about three atmospheres, will not heat the air much during compression. This, as is well known, is the difficulty experienced in obtaining economical results from compressed air.

The hammer from which these diagrams were obtained is a 3 cwt. size. Fig. 5 is interesting; the screw wrench shown was drawn from a 4 in. square piece in four heats. This is smart work, and equal I think to anything an ordinary 3 cwt. steam hammer could do. Fig. 6 is a photograph of an electrically-driven hammer of this type in the 3 cwt. size. When direct-driven in this manner a motor of the enclosed ventilated (semi-enclosed) type is recommended, and if by continuous current, perferably compound wound. I have been furnished with the following table by Messrs. Masseys, and it will no doubt prove interesting showing the remarkably low horse-power required when compared with the size of hammer. It is evident to the writer from a trial of this Massey's pneumatic power hammer, that the makers have succeeded in producing a tool which not only is capable of dealing with anything a steam hammer of equal size can do, but is far and away cheaper in running costs. Power hammers have now evidently passed the experimental stage and have become practical and reliable tools.

3. Size and Speed.							
Weight of falling parts	1 cwt.	2 cwt.	3 cwt.	5 cwt.	7 cwt.	10 cwt.	15 cwt.
Blows per minute ..	240	..	140	120	115	110	105
Longest stroke in.	12	..	17	21	24	27	30
Power.							
Maximum (full blows) B.H.P.	6	..	10	15	19	29	40
Mean consumption, per § 2 above (for estimating cost) B.H.P.	2	..	3·5	5	6·5	10	14
Particulars of Motors.							
Size (continuous rating) B.H.P.	4	..	7	10	13	20	27
Speed (approx. at full load) for direct gear drive)	900	..	800	750	750	650	650
Speed (approx. at full load) for direct belt drive)	900	..	600	600	600	500	500

IRON CAR DEPOTS.

In an electric tramway system the shed for housing the cars runs to a considerable amount of money, whilst at the same time its load factor (if it may be so termed) is very low, inasmuch as it is only in use for a very few hours out of the twenty-four. Large expense is therefore hardly justified, especially when one considers that the cars themselves have to run through all kinds of weather, and therefore to provide an exceptionally tight building is hardly necessary. The cheapest form of construction is a steel structure, with corrugated-iron walls and roof. Such a building, of two spans, each 250 ft. long and 75 ft. wide, and measuring 20 ft. to the eaves, would cost from 2s. 6d. to 3s. per square foot of ground surface covered, or about 1¼d. to 1½d. per cubic foot of contents. Of course, appearance goes for something, and no one would pretend to say that such a building can claim to be beautiful. At the same time in electrical work one never knows what is going to happen in 30 or 40 years' time, and as an iron building will easily last so long it would seem to meet the case very well. The corrugated iron should be at least 22 B.W.G. thick, and overlap 6 in. at the end and one corrugation at the side. A dwarf wall of brick must be provided all round the base of the building, the top edge being champered off and arranged to make a neat weather-tight joint with the galvanised iron. Of course, it is vitally important that such iron buildings should be kept well painted.

Belfast Corporation and the Tramways.—The arbitrator's award in connection with the sale of the Belfast Street Tramway Company's undertaking to the Belfast Corporation was made on March 31. The total amount of the award is £356,948 14s 6d., out of which £60,000 has to be paid to the debenture holders, leaving £296,948 14s. 6d. due to the company. The company claimed £392,345, and the Corporation's estimate was between £250,000 and £260,000.

Chester Corporation Tramways Scheme.—Some time ago Chester Corporation decided to extend their electric tramway system at a cost of about £17,000. The matter, however, was deferred in order that the advantages of motor 'buses might be considered. At a meeting of the Tramways Committee on March 24, reports on the subject were presented, and it was decided to recommend the Corporation to proceed with the scheme for electric tramways.

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THE GLASGOW STANDARD TOP COVERED CAR.

We give herewith an illustration of the covered double-deck car now adopted by the Glasgow Corporation as their standard type. In designing this car, an effort has been made to secure comfort and usefulness in a very high degree, while preserving, as far as possible, the good appearance of the car. The conclusion arrived at by the tramways committee is that, taking everything into account, the fixed roofs and fixed windows with ample ventilators are best adapted for the requirements of the service. There is, of course, much less maintenance with closed roofs and windows. The side ventilators are geared in a simple manner, so that on either side of the car they can all be opened or closed by one operation. With the end ventilators they provide ample ventilation, and are entirely under the control of the conductor.

Glasgow Standard Top Covered Car.

To provide outside seats for a few passengers on the canopy deck, the platform of the car has been lengthened by a foot. This enabled an easy and convenient stairway to be put in, which in no way obstructs the motorman's view, and which is so placed that passengers can, at the same time, descend from the upper deck and leave the platform without interfering with passengers leaving the lower portion. The controller and brake handles are so placed in front that the motorman occupies a commanding position, and there is space for a glass shield over the dash in front should it be wanted at any time. The car body is exactly the same as the present top deck standard car, and is seated for 24 inside. The cover, it will be observed, is the same length as the car body, and as the canopy extends over the full length of the platform, outside accommodation is provided for five passengers at each end. The seating capacity of the covered portion—with the absence of the trolley standard and a re-arrangement of the seats—is 32, thus giving a total seating accommodation for 66 passengers.

The construction of the upper roof in the present standard cars gives a clear headroom of 6 ft. 1 in. The side pillars and roof ribs are of polished ash, and lining of narrow polished pitch pine and cherry alternately. It will be observed that the step to the platform is made to fold up. From an artistic point of view the lengthening of the platforms, and, correspondingly, of the protecting sheet and railing round the canopy over the platforms, gives an appearance of greater weight to the body of the car, and, in effect, reduces the proportions of the top cover—which have been actually reduced by the lighter side pillars required for the fixed windows—all tending to give the car a more graceful appearance.

One hundred and twenty of the present standard cars are now fitted with top covers and in service, and one hundred new cars of the same design are in course of construction. The first of these will be turned out from the department's own works in May and, with a regular output thereafter of four per week, by the end of October two hundred and twenty top roofed cars will be in service. So satisfied are the committee with this type of car that at their last meeting they decided to proceed with the fitting of another hundred roofs to standard cars.

CALEDONIAN RAILWAY AND TRAMWAY COMPETITION.—Sir James Thompson, speaking at the meeting in Glasgow on March 14, denounced the Glasgow Corporation for extending electric cars to the suburbs and to country places outside the city. Such competition, he said, was hurting the railways, and was not a legitimate form of municipal enterprise. It was a grave danger, as it induced the population to reside outside the city boundary, and increased the burden of taxation upon those who remained. The Caledonian Railway Company was Glasgow's biggest ratepayer. He urged shareholders in all enterprises to oppose electric car extensions

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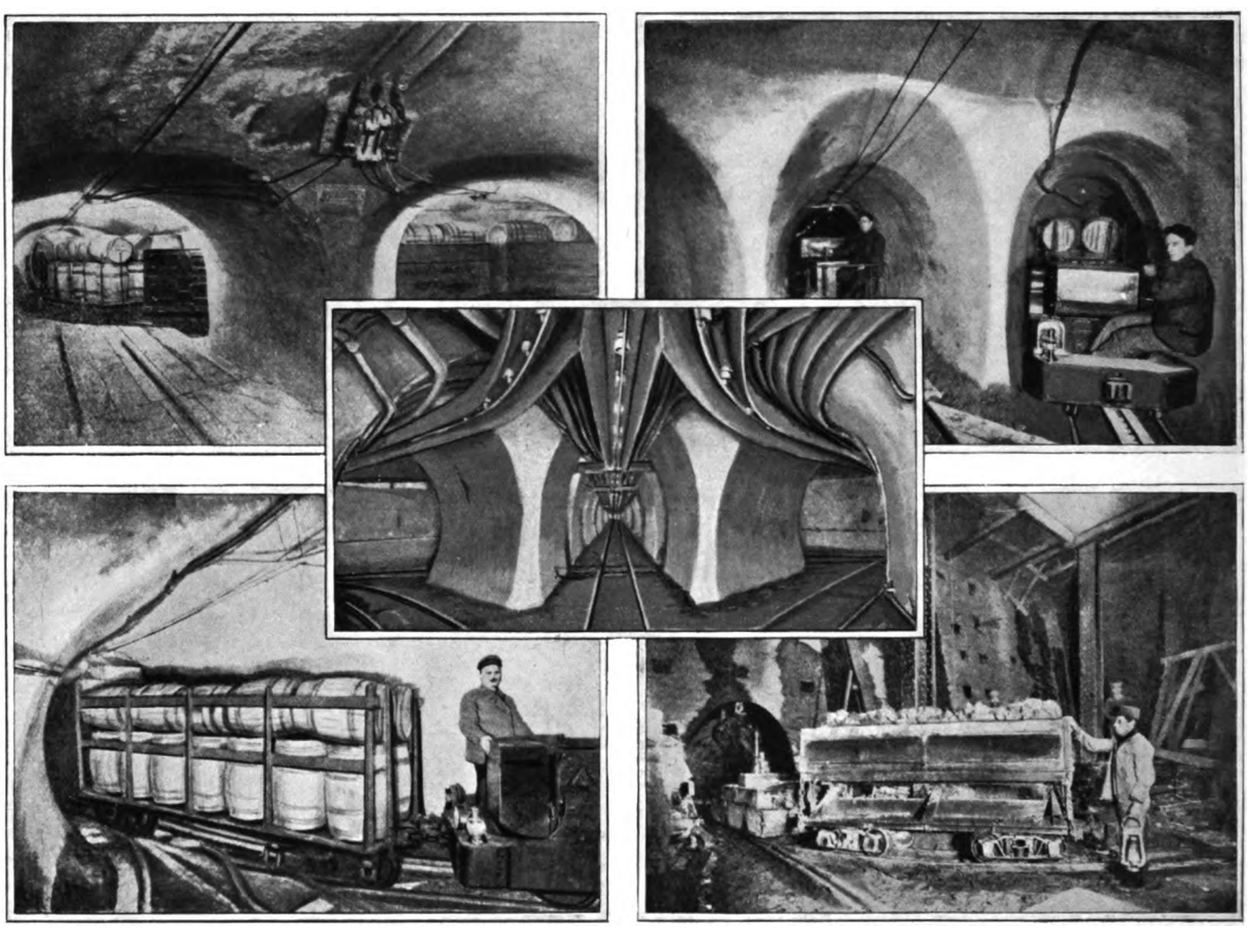
GOODS SUBWAYS IN CHICAGO.

In a paper read by Mr. Robert P. Porter before the Society of Arts on January 25 last, on the subject of underground railways, some reference was made to the system of underground electric railways in Chicago, which are used for freight traffic only. An abstract of the paper was published in our issue of February 9, and we now give some further details, along with illustrations of these tunnels. The scheme is at present unique, but probably, if found successful, it will be imitated elsewhere. It is, at all events, based upon a very sensible idea, and the only question is how far that idea can be carried out in practice. The notion is that it is better to put goods traffic underground, and so free the streets for passenger traffic, than to carry the people on underground railways and work goods and minerals along the streets by carts, etc.



Views in Goods Subways in Chicago.

The Chicago tunnels were originally intended for the accommodation of telephone wires and cables, and their construction was commenced by the Illinois Telegraph and Telephone Company in 1899. In 1903 the Illinois Tunnel Company was granted a franchise for handling freight, express, and mail service in tunnels by means of electric traction. This company is controlled by the leading railroad companies whose lines enter Chicago. There are 38 railway stations in the centre of Chicago, and over 112,000 tons of freight are daily moved to and from them. This situation caused great congestion in the streets, and this the subways have met and relieved. The cars of the tunnel company are run directly into the railway freight houses, loaded, and run through the tunnels to the consignees. Here the cars are run into the basement of the warehouse through an opening cut in the masonry, raised to the desired floor on elevators, and unloaded. If the goods are not intended for immediate delivery, the cars are run into the company's storehouses and kept there till required. Every building on the route of the tunnel can be connected to it by a lateral shaft for the above purpose.

The work on the telephone tunnels was planned in 1899, but did not actually begin until September, 1901. It was found that the space below the paving was almost completely taken up by water and gas pipes, sewers, and the conduits of other companies. It was then decided to build a deep tunnel system, with trunk line tunnels 12 ft. 9 in. by 14 ft., and branch tunnels 6 ft. by 7 ft. 6 in.

The boring was almost entirely through firm clay, but the compressed air system was used. About twelve miles of tunnels were completed in ten and a half months. Concrete was placed in the bottom of the excavation and thoroughly tamped, the lagging placed on top of the concrete, iron ribs made of channel bars being placed on the bottom three feet apart, and the lagging laid at the sides against these ribs. The concrete was then thrown behind the two-inch plank lagging in six-inch layers. The use of concrete absolutely avoided any chance of settlement of the earth, as it was tamped into the entire space between the lagging and the excavation, no matter how irregularly the digging or mining had been done. For part of the work steel lagging plates were used as a special precaution, on account of the extra weight of the concrete. In proceeding with the work, the face of the preceding day's work was cleaned and a plaster coating of cement, made in proportions of one to one, sand and

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cement, was plastered on the old work, forming a seal and making the structure almost entirely a homogeneous one. The 6 by 7½ lateral tunnels were constructed with 13 in. bottoms and 10 in. walls of concrete. The trunk tunnels have 21 in. bottoms and 18 in. walls.

An equipment of small cars, some 900 in number, built to run on a 14 in. gauge, double-track system, was provided to dispose of the excavated material. The cars were hoisted by power-driven elevators up the shafts to the head-houses and the material dumped into wagons. Much of this was deposited on the lake front, a special 10-ton, stiff-leg derrick being provided for unloading the wagons. In this way much valuable land was added to Grant Park.

The steepest grade in the tunnels is 1·75 per cent., and the grades at the railway terminals do not exceed 12 per cent. The latter steep grades form the approaches to the tunnels, which are built with the rails some 30 ft. below the street level. The four-way intersections have curves of 20 ft. radius, and the sharpest curves on the main lines are of 16 ft. radius.

The track is 2 ft. gauge, laid with 56 lb. T-rails, fastened by bolted clamps to cast-iron chairs imbedded in the concrete floor of the tunnel. Part of the system is overhead trolley, while the rest is of the Morgan third-rail traction system. This latter involves the use of a perforated metal plate (½ in. thick and 4 in. wide) forming a rack which is bolted between two lines of timber stringers. These serve to protect and support the rail. A special construction for the tunnel work was devised in the use of chairs of bent steel channels to support the rack. The locomotives are of the class used in mine haulage work, but are peculiar in the method of taking current. The rack rail serves both for traction and as a third-rail conductor, the current being led to motors geared to the axles, with suitable controlling devices. The track rails are used for the return current. The wheel-base of the locomotives is 24½ in. With one 75 H.P. motor the weight is about 3 tons; with two 60 H.P. motors, about 5 tons. The trolley locomotives are of the type used in mines.

The whole system has not yet come fully into operation, but in the course of the coming summer it is expected to be in full swing. Besides bringing coal and goods to warehouses and factories, ashes are removed, and under arrangements with the Post Office 880 tons of mails will be handled in the tunnels daily.

STANDARD FLAT-BOTTOMED RAILS.

The Engineering Standards Committee have issued a report by their sub-committee on railway rails dealing with the flat-bottomed variety. This sub-committee, which is under the chairmanship of Mr. James C. Inglis, of the Great Western Railway, was appointed on October 31, 1901, at the same time as the sub-committee on tramway rails, which has already reported. The draft specification for flat-bottomed rails was submitted to the chief engineers of the principal British and Irish Railways, and to several engineers who are large users of flat-bottomed rails, and the final specification was approved by the main committee on February 1 last. The following points are abstracted, but for the complete particulars, along with numerous tables and drawings, reference should be made to the report itself, which is published by Messrs. Crosby, Lockwood and Son, at the price of 10/6.

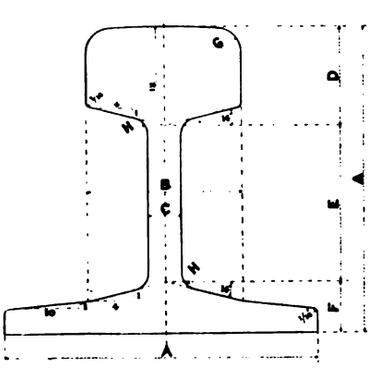

Fig. 3.—Key to Table of Dimensions.

The chemical composition stipulated is: Carbon, from ·35 to ·5 per cent.; manganese, from ·7 to 1 per cent.; silicon, not to exceed ·1 per cent.; phosphorus and sulphur, not to exceed ·07 per cent. each. Arrangements are set out for the taking of chemical analysis of the steel, for work to templates etc. As to

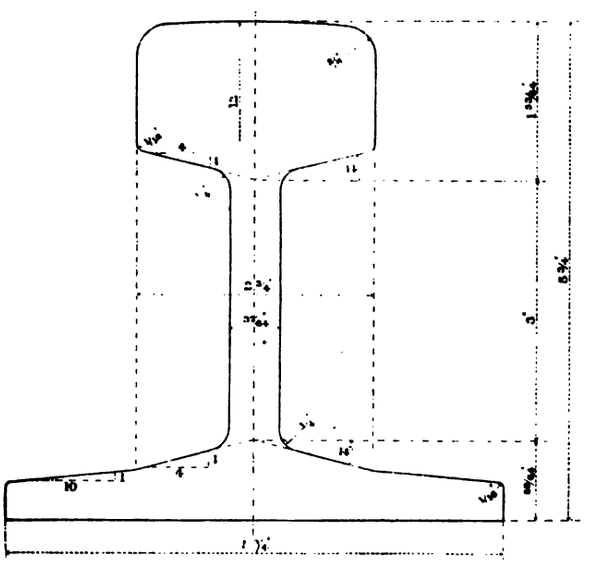

Fig. 1.—Section of Standard Rail—100 lb. per yard.

lengths, no rail will be accepted which is more than 1/16 in. above or below the length specified at 60 deg. Fahr. A specified brand is to be rolled on the web of each rail to show that the rail is of British standard section and made under the condition of the specification. The other marks on the rail are to include the number of the section, the process by which the rails have been manufactured, the manufacturer's name, initials, or mark, and the date. A table is given for impact tests, and as to tensile test the ultimate strength

Lbs. per yard	A		B		C		D		E		F		G	H
	Inches	Parts of an inch	Inches	Parts of an inch	Inches	Parts of an inch	Inches	Parts of an inch	Inches	Parts of an inch	Inches	Parts of an inch	Inches	Inches
20	2 1/8	4	1 3/8	4	11/64	2	25/32	8	1 19/64	5	7/64	3		
25	2 3/8	4	1 7/12	4	7/64	2	29/32	6	1 3/8	7	15/64	3		
30	2	4	1 5/8	4	3/64	2	1	6	1 29/64	6	23/64	2	1/8	3/16
35	2 1/4	4	1 7/8	4	3/64	2	1 5/32	4	1 29/64	10	31/64	2		
40	3 1/2	4	1 3/4	4	3/64	2	1 5/32	5	1 29/64	9	39/64	2		
45	2 3/4	4	1 29/32	3	3/64	2	1 15/64	5	1 29/64	5	47/64	2		
50	2 15/16	3	2 1/16	3	3/32	1	1 1/16	5	1 29/64	7	5/64	2	7/32	5/32
55	3 1/8	3	2 5/32	3	7/64	2	1 19/64	3	2 5/64	6	11/64	3		
60	4 1/32	3	2 3/8	3	3/64	1	1 9/32	3	2 5/64	7	13/64	2		
65	4 7/16	2	2 11/16	2	3/64	2	1 29/64	4	2 7/32	8	3/8	2		
70	4 3/8	3	2 3/4	2	3/64	2	1 3/4	2	2 7/32	7	29/64	2		
75	4 7/16	3	2 7/16	2	7/32	1	1 29/64	3	2 29/64	7	9/16	2		
80	5	3	2 1/2	2	3/64	1	1 19/32	4	2 9/16	7	25/32	1	3/16	1/4
85	5 1/16	3	2 9/16	2	3/32	0	1 21/32	5	2 45/64	7	55/64	2		
90	5 3/8	3	2 5/8	2	3/32	1	1 25/64	5	2 25/64	8	5/32	1		
95	5 7/16	3	2 11/16	2	5/64	0	1 3/4	5	2 29/64	6	29/32	1		
100	5 3/4		2 3/4		3/32		1 25/64		3		5/64			

Fig. 2.—Table of Dimensions.

is to be between 40 and 46 tons per square inch, with an elongation of not less than 15 per cent.

The standard sections of rails are illustrated in the report, varying from 20 lb. to 100 lb. per yard. The last mentioned is here reproduced (Fig. 1). Fig. 2 is a table of dimensions for the different weights, which, along with the key drawing (Fig. 3) forms a convenient method for getting any dimensions required.

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THE PRODUCTION OF ELECTRICAL POWER.

Switchboard Instruments.

When an electric current flows through a conductor we have seen that it produces a magnetic field around it. This field will affect any magnet placed in it, and by utilising this fact we are able to construct dynamos for producing electric currents and motors for converting electrical energy into mechanical energy. We make use of the same principle in many of our measuring instruments. In some cases a moveable piece of soft iron, with a long pointer attached, and mounted on pivots, is caused to move by means of a current flowing through a coil of wire. In other cases, coils of wire through which the currents are caused to pass are suspended in the magnetic field between the poles of a magnet in such a way that the position of the coil is controlled by the field of the magnet and the lines of force due to the current passing through the coil.

Fig. 42 is a diagrammatic representation of an ammeter of the soft iron type. A and B are the terminals of the instrument. A current entering at A flows through the coil FG, and leaves by the terminal A. The soft iron wire DE is affected by the field produced, and is drawn towards the coil. The soft iron is attached to a small disc pivoted at C, and is capable of rotating about this point. The disc also carries a long pointer CJ, and an adjustable weight H. When the coil FG attracts the wire DE, it moves the end J of the pointer along the scale JK, and at the same time raises the weight H. The end J of the pointer will move to a position on the scale such that the tendency of the weight H to move downwards just counterbalances the tendency of the wire to move further into the coil. Currents of different strength will consequently move the pointer to different positions. It is evident that in an instrument of this type the position of the pointer is controlled by the force of gravitation, and such instruments are spoken of as gravity controlled instruments.

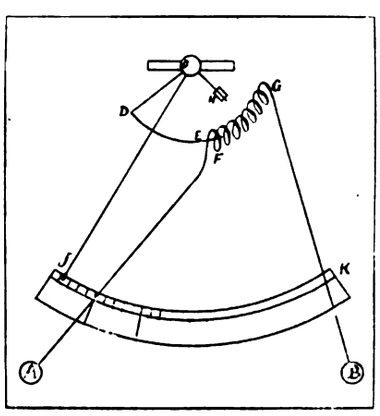

Fig. 42.

Another type of instrument, similar to the one just described, is one in which the controlling influence of the weight H is replaced by that due to a fine spring. The spring frequently used is very similar to the hair-spring of a watch, but instead of being made of steel it is made of some non-magnetic substance such as phosphor-bronze. Such instruments are spoken of as soft iron, spring-controlled instruments. Unfortunately these soft iron instruments are not altogether satisfactory in use, as they are liable to be affected by variations in the magnetic field in which they are placed. They are, however, largely used, chiefly on account of their cost, being lower than that of instruments of the moving coil type.

An instrument such as those just described may be constructed so as to be used for measuring the strength of a current in amperes, when it is known as an ampere-meter or ammeter; or it may be constructed suitably for measuring potential differences in volts, when it is known as a voltmeter. If the instrument is to be used as ammeter, then the resistance must be made as low as possible, for it will be evident that if the current to be measured is passed through the instrument, and the resistance is high, the strength of the current will be altered in value and an incorrect measurement will be made. Of course, we cannot make an ammeter without some resistance, but the smaller the resistance the better, and we can make the resistance small by making the coil of thick wire and short in length. The resistance of an ampere meter reading to 200 amperes will be found usually to be of the order of ·001 ohms. If the resistance were high, the power lost in the instrument would be considerable (being equal to C^2R), and since an ammeter is usually kept continuously in circuit the loss would also be continuous.

After the ammeter is made, it must be calibrated. This may be done either by means of a silver or copper voltameter, by comparison with a standard ammeter or by means of an instrument called the potentiometer. Suppose we decide to calibrate the instrument by means of a standard ammeter. We pass the same current through the two ammeters in series, adjust the current strength to some definite division on the standard ammeter, and mark the position on the ammeter being calibrated. We proceed in the same way with other divisions. When this has been done all along the scale the divisions are carefully inked or painted in and numbered.

If the instrument is to be used as a voltmeter then the resistance should be made high by using thin wire and a great number of turns in the coil. Unlike the ammeter the voltmeter is always placed as a shunt between the two points whose potential difference is to be tested. If the resistance between the two points under test is very small compared with the resistance of the voltmeter then only a very small fraction of the whole current passes through the voltmeter, and the conditions in the circuit are very little interfered with. If on the other hand the resistance between the points under test were greater than that of the voltmeter then more than half the current would flow through the instrument, and this would alter the potential difference between the two points considerably. Hence it is advisable to make the resistance of a voltmeter high.

The range of a voltmeter or an ammeter can be varied in several ways. It can be varied by altering the number of turns in the coil and by altering the diameter of the coil, by altering the strength of the control, or by placing shunts across the terminals of the instrument. For instance, suppose we have an ammeter with a scale extending from 0 to 50 amperes, and we wish to use it from 0 to 500 amperes, we can do this by placing a shunt across the terminals, such that $\frac{9}{10}$ of the current passes through the shunt, and therefore only $\frac{1}{10}$ through the ammeter. For this the shunt would require a resistance of $\frac{1}{9}$ that of the ammeter.

The moving-coil type of instrument is shewn in Fig. 43. This represents the interior of the Weston instruments so largely used on electric-traction switchboards. The whole instrument is built up on the large ∩-shaped permanent magnet A. A gun-metal casting B is attached to this magnet, and this is screwed to the bottom of the case. Two soft iron pole pieces N and S are attached to the magnet, and these are bored out so as to admit a cylinder of soft iron I, leaving a narrow annular space of about $\frac{1}{8}$ in. width round it. In this annular space is supported a light rectangular metal frame C, carrying a coil of fine wire. The frame is supported by two pivots working in hollow jewels in the points of the screws E and D. The current is led into and out of the coil by means of two fine

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hair-springs L and K of phosphor-bronze. These springs also serve as control to the coil. A long pointer is also attached to the upper part of the moving coil, and this moves over the scale R. The instrument is adjusted so that the coil sets itself normally in a position approximately at 45 deg., with the line joining the centres of the two pole pieces.

When a current is sent through the instrument the current tends to set the coil at right angles to this line. The direction in which the coil tends to turn depends upon the direction of the current, and since the construction of the instrument is such that the coil can only move one way from its normal position the proper terminals must be connected to the points at higher and lower potentials.

Since in this instrument the space available for the coil is small the coil must be made of comparatively fine wire. If the instrument is to be used as an ammeter a shunt must be placed across the terminals, otherwise the resistance will be too great. If the instrument is to be used as a voltmeter the coil is wound with very fine wire, and an extra coil of high resistance is connected in series with the moving coil. In each case the shunt or coil is usually enclosed in the case of the instrument.

When a current is passed through the instrument the turning effect on the moving coil is due to the coil itself which then acts as a magnet, and to the strong magnetic field in which it is placed. Since the magnetic field is very strong the number of turns of wire in the coil need not be great. The chief advantage, however, of the moving coil type of instrument is that it is not affected by other magnetic fields, as the coil is protected by the iron and steel around it, and any stray fields are moreover likely to be very small compared with the field between the poles of the magnet. In addition to the voltmeters already described there are voltmeters of another type in which a magnet is not used, but the attraction between two pieces of metal oppositely charged is utilised. Such voltmeters are known as electrostatic voltmeters. Fig. 44 shows Lord Kelvin's multicellular electrostatic voltmeter. Two sets of metal vanes are mounted on a spindle and suspended by a platinum iridium wire from the cap of the instrument. The sheet metal vanes on the spindle move between two sets of vanes attached to brass pieces insulated from the frame. When the two sets of insulated vanes are connected to two points between which the difference in potential is required, the spindle carrying the vanes is caused to move.

The movement is opposed by the torsion which this puts on the suspension wire. A pointer is attached to the spindle, and this moves over a scale graduated in volts. Hanging from the spindle is a disc immersed in oil, and this forms a suitable damper to the motion of the spindle.

These electrostatic voltmeters absorb practically no power, as no current flows through them. They also work equally well with alternating and direct currents, and with alternating currents the periodicity produces no effect. For very high voltages the number of vanes used is reduced to two.

On the switchboard of any power-station, in addition to various voltmeters and ammeters, will be found recording ammeters and voltmeters for automatically recording the changes in current and voltage. The instruments are the same in principle as those already described, with the addition of a pen on the pointer and a roll of paper driven by clockwork under the pen. A time scale is marked on the paper so that the reading at any time can be found. Fig. 45 shows one of Messrs. Elliott Brothers recording instruments with the front removed.

By taking the readings of the ammeters and voltmeters and multiplying the two together we get the power being used in watts. Dividing this by one thousand, we obtain the power in kilowatts. If again we multiply this by the time in hours during which the energy is supplied we get kilowatt-hours or Board of Trade units. Watt-hour meters are also used for giving this direct.

On the switchboard are also found various forms of switches and circuit breakers, into the description of which, however, it will not be necessary for us to go, as their action is easily understood when seen in operation.

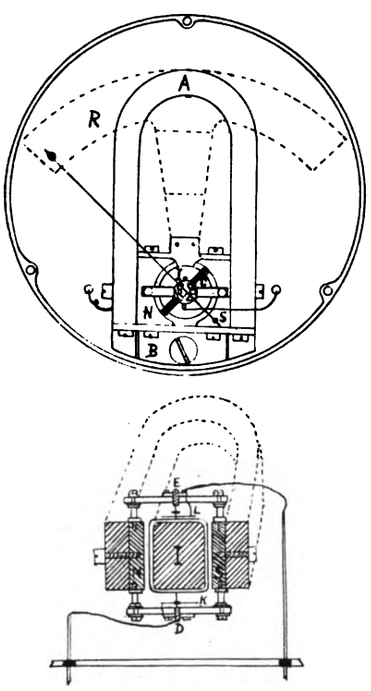

Fig. 43.

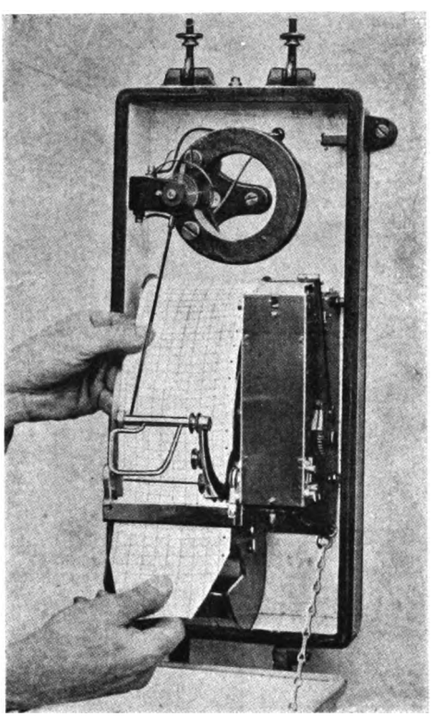

Fig. 45.

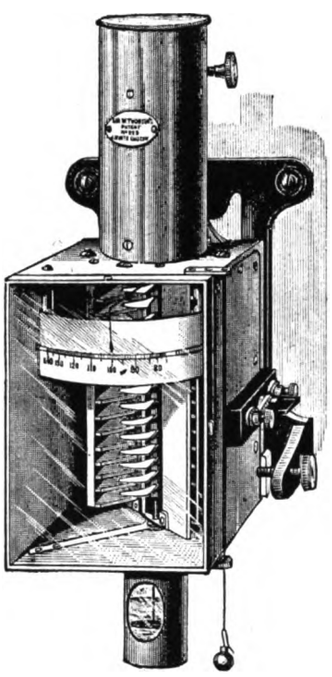

Fig. 44.

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THE

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We shall be pleased to receive at all times articles, papers, notes, and correspondence on subjects of interest to those concerned in the financial administration, construction, or management of tramway and light railway undertakings. Particulars as to the issue of specifications, the progress and completion of contracts for new work, and suggestions for improvements in all branches of tramway enterprise will receive special attention.

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LONDON, APRIL 6, 1905.

London Motor 'Buses.

There appears to be some prospect of the motor omnibus business in London being overdone, even in its first days. During the past month the prospectuses were published of two new motor 'bus companies, each of which promises to have one or two hundred vehicles on the streets by midsummer. A third company of the sort was previously at work, and it also promises to develop. The General Omnibus Company, the Road Car Company, and other existing concerns announced some time ago that they will as speedily as possible have motor 'buses running on all their principal routes. These, of course, will take the place of horse 'buses, but the vehicles of the new companies will be pure additions to the traffic on streets which in many districts are already badly congested. Two things accordingly are in prospect—one that the streets will be more thronged than ever, and the other that the 'buses will not pay. As time goes on the latter circumstance will cure the former, and as a consequence cure itself; but in the interval there will be much inconvenience to the public and considerable loss to omnibus shareholders. Of course there is no absolute certainty that these things will happen; all we say is that, if all the promises of the companies are carried out, they are very likely to happen. At one time in this country we had the railway mania, and it cured itself in the bitter school of experience. There never was any very acute tramway mania, but it certainly appears as if there was a promise of a mild motor 'bus mania.

London Power Bills.

The great Parliamentary struggle before a Select Committee of the House of Lords on nine electric-power distribution bills affecting the whole of London has not any immediate bearing on electric-traction matters in the metropolis, but the results may prove of importance in the future to railway companies having lines in and near London, and to tramway companies in the vicinity. If a great scheme of electric-power supply should come into existence, capable of selling energy at a much lower rate than present prices, it is quite possible that some of the railway companies when electrifying their local lines may find it desirable to buy the energy from a company rather than to erect and run their own power-stations. This has already been done in the case of the North Eastern Railway and the Newcastle Electric Supply Company. Future tramway undertakings near London might also be supplied in the same way, and there is already a local example of that in the case of the Middlesex Light Railways. From the point of view of comprehensiveness the Administrative County of London and District Electric Power Company Bill is the greatest of the competing schemes, and it has met with strong opposition both from local authorities and from the existing electric supply companies, the latter of whom are promoting bills of their own. The whole subject in London is beset with enormous difficulties. One of the questions on which there will always be difference of opinion is whether competition should be allowed. On the broad merits, the bigger the scheme is the better it should be both for the public and for the undertakers. The work to be done is not at all in the sphere of

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local authorities, because though something can be said for their supplying electric tramways, no good argument seems available for their supplying power to railways and factories. Moreover, a good scheme must embrace the areas of many local authorities. It is highly probable that ere this London would have been in possession of extensive electric power-distribution undertakings had it not been for the fetters of the Electric Lighting Acts. The existing companies being liable to be bought out by the local authorities, just as tramway companies are, have been prevented from developing the power-supply branch of the business. The great electric power companies of the country have had these bonds relaxed, and that is one of the things which is now sought by the London bills.

The Importance of the Reserve Fund.

Both those who study and those who manage tramway undertakings may usefully have their attention directed to recent developments in street railway finance in America. Electric railways there have suffered from the keen desire of promoters and owners to dispose of shares and bonds at as high a price as possible. To this end no effort has been spared to make net earnings high, and the result has been astonishingly successful. This success has, however, proved to be in many cases short-lived because, in the effort to obtain it, all available surplus has been paid out as dividends, the maintenance of the equipment receiving in the meantime the least possible attention. Under the influence of large net receipts—arrived at in this fashion—money for extensions was easily obtained, and these extensions have in their turn been worked for high net receipts. No reserve was put by in the "boom" period to meet the large sums that would have to be spent on maintenance almost simultaneously. In these circumstances, what was foreseen by the more far-sighted investors has happened. Even in conservative Massachusetts the evil of unjustifiably high "net receipts" appears now to be felt. Some three months ago the chief street railway organisation paid no dividend. According to the New York *Financial Chronicle* this company works 854 miles of street railways in 88 cities and towns, and it had for some time previously been paying 4 per cent. annually on the preferred stock. There are reports of other large street railway properties being on the verge of bankruptcy, and in all cases the explanation appears to be found in excessive capital and in a system of finance which has considered a high net revenue—however arrived at—to be the chief end of management. When maintenance charges are considered beneath the attention of successful financiers, it is little wonder that a period is soon reached when dividends are passed and success is brought to an abrupt termination. Much of the trouble in American street railways has, of course, arisen from the inflation of capital. Steam railway companies there no doubt set a bad example in this respect; but electric railway companies have not been inapt pupils. While the average capitalisation of the former in 1903 was about £12,000 per mile, the electric railways showed an average funded capital of £23,339 per mile. Many of the lines have an enormous traffic, and will always prove profitable, but there are many others which, if the present policy with respect to maintenance be followed, must fall into the hands of those who better understand the business.

* * *

In this country the evil of over-capitalization is not so widespread, but it is not unknown. Many electric lines that would do well enough if charged only with the actual capital cost can scarcely pay fixed charges on the funded capital, to say nothing of making a proper reserve for depreciation. Sooner or later the cost of necessary maintenance will have to be met, and the day of reckoning will not be a pleasant one. Both tramway companies and Corporations will have to face the fact that depreciation will be a heavier charge than has been anticipated. When plant is new the necessity of making adequate provision for maintenance is not so easily appreciated, but as the track and cars grow older it will be found that increasingly large sums must be spent upon them. In the case of many municipal tramways the full effect of the normal wear and tear on equipments and track is already beginning to be seen by officers and committee with considerable alarm, and steps are being taken to conserve the tramway revenue, so that the departments may be placed in a thoroughly sound position. In other towns, however, no accurate forecast appears to have been made, and the tramway revenue is being labelled "net

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revenue," in the American fashion, before due allowance has been made for depreciation. We have no wish to pose as alarmists; but it is well that the facts should be seen as they are. In a number of towns the revenue from the tramways now distributed in relief of the rates ought, undoubtedly, to be placed to reserve until a fund of a reasonable amount has been accumulated. Then, and then only, can a tramway department be considered to be in a satisfactory position; for besides the necessity for ordinary maintenance it must be borne in mind that extraordinary changes in equipment may within a comparatively short time be forced upon tramway undertakings by new inventions and improvements.

CORRESPONDENCE.

To the Editor of the Tramway and Railway World.

Running Powers.

Sir,—It may be owing to my "mis-spent life and infantile mind," but I utterly fail to see in Mr. Sellon's letter any connection with the remarks I ventured to send you on the above subject. I spoke from the point of view of a manager of a street railway or tramway, and, on this particular question, no comparison is possible with the ordinary railroad. I fully concede to Mr. Sellon the palm for smartness. He will hardly demand it for courtesy!

Your obedient servant,

Twenty Years a Manager.

To the Editor of the Tramway and Railway World.

Financial Results from London County Council Tramways.

Sir,—My attention has been called to a circular letter which has been issued by Messrs. Thomas Tilling, Limited, omnibus proprietors, with the intention of exciting opposition to the proposal contained in the Council's Tramways Bill of the present Session for the construction of tramways over Westminster Bridge, along the Victoria Embankment and over Blackfriars Bridge to connect the existing tramway termini in Westminster Bridge Road and Blackfriars Road. The letter contains the following paragraph:

"You can safely affirm that these tramways are not self-paying, and that a better service can be given to the travelling public with motor omnibuses by private enterprise, and without being a burden to the rates."

This statement is to my mind likely to so seriously mislead the House of Commons in its consideration of the Council's proposals that I desire to trespass shortly upon your space to indicate what are the facts concerning the working of the Council's tramways.

The Council's tramways have from the first year that it acquired control of any lines in London been entirely self-supporting, and they will continue to be so. Even during the years when the bulk of the tramways south of the Thames were being reconstructed for electrical traction, entirely disorganising the ordinary traffic (some of the lines being closed altogether), the tramways account has never been a charge to the extent of a single penny upon the rates. On the contrary, the tramways have already during the past eight years paid from surplus revenue in reduction of rates, after the provision of interest and sinking fund charges, a sum of over £293,000, divided between the Northern and Southern systems.

The following details as to the application of the moneys received from the tramways account during the past eight years, in respect of the Council's systems North and South of the Thames indicate the absolute inaccuracy of Messrs. Tilling's statement.

	£
Applied in reduction of rates, over	293,000
Amount paid for Sinking Fund charges in reduction of debt during the same period (Northern System, which has been in Council's hands for eight years, £117,044; Southern System, which has been in Council's hands six years, £210,195; and general, £6,997)..	335,236
Amount paid for interest on capital	414,000
Amount set aside as a reconstruction, renewals, reserve fund for the Southern System	66,000
Amount paid in rates and taxes in respect of the Southern System during the past six years	90,000
Amount paid in reduction of debt from proceeds of sale of horses, rolling stock, surplus property, etc.	126,220

During the four years from 1889 to 1903 the 48 miles of tramways north of the river, which are leased by the Council, earned as profit, after paying interest and sinking fund charges, £153,700, while the 24 miles on the south side of the Thames, worked by the Council itself during the same period, provided, after paying corresponding charges, the sum of £72,900.

The following facts are of importance in any institution of a comparison between the results from the system north of the Thames, leased to a company, and the lines south of the river worked by the Council itself. These illustrate the advantages that have been secured to the travelling public and the amelioration of the conditions of labour of the tramways employees obtained from the Council's immediate control.

1. 200,000,000 passengers were carried at halfpenny fares, as compared with a penny, the minimum fare on the north. This represents a very considerable money value to the travelling public on the south side of the river.

2. Workmen's cars, running up to 8 a.m., have been instituted, with a fare of one penny for any distance for a single journey on the existing lines, and 2d. for a return journey, which means a very valuable boon to workers using the southern lines. In addition, all-night car services have been established.

3. The Council has conceded to its employees a six-days' week and a 10 hours' day, which with certain other improvements in the conditions of labour, represent an expenditure beyond that involved under this head when the tramways were acquired, of over £30,000 a year. This ensured the granting of conditions of labour which were considered necessary to secure efficient service.

During the period of reconstruction there was a deficiency in the southern tramways accounts of £2,250 in 1902-3, and of £8,284 in 1903-4. This result was brought about by the Council paying interest and sinking fund charges of £12,300 on expenditure incurred for reconstruction before a single electric car was run on the lines creating those charges. Moreover, during the first-named year a sum of £11,000 was set aside out of revenue for the renewals fund for the horse lines, which were at the time entirely disappearing. The result of this was to give to the Council as an asset in the way of a renewals reserve fund a sum of £30,750 at the commencement of electrical working, before any wear and tear had begun, and the "account deficiency" is thus amply covered by assets more than corresponding thereto.

The facts therefore only serve to illustrate the soundness of the Council's tramways finance policy. In regarding this aspect of the matter, I should like to point out that, contrary to company practice, the capital expenditure, a term by no means elastically interpreted by the Council, is being steadily paid off, and the tramways are being put in a better financial

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position every year, a constantly increasing sum being available by way of surplus receipts. In other words, a leasehold property is being rapidly converted into a freehold one, while a company undertaking remains a perpetual leasehold. The importance of this point cannot be overestimated.

As the period of reconstruction passes away the "account deficiencies" will entirely disappear, and it is important to note that the accounts for the present year show a very substantial surplus, after the payment of the very heavy capital charges upon the lines that have been reconstructed. To the impartial expert, it would appear that the Council has surmounted the difficulties of traffic maintenance and organisation during the trying period that comes in the history of every horse-propelled tramways undertaking when improved methods of traction have to be applied to the lines, with remarkable success.

In criticising Messrs. Tilling's letter in the light of the actual facts I can only think that they are not prepared to rely upon the efficiency of the motor omnibus service as a means of locomotion in fair and open competition with the tramways service. I cannot otherwise account for the methods adopted by them in their endeavour to defeat the Council's efforts to improve the locomotion system of London in the best interests of the travelling public.

I am, Sir,
Your obedient Servant,
J. ALLEN BAKER,
Chairman of the Highways Committee.

County Hall,
Spring Gardens, S.W.,
March 31, 1905.

PROPOSED TRAMWAY IN NANKIN.

Mr. Wilbur T. Gracey, vice-consul of the United States at Nankin, China, reports that he has recently been in consultation with the viceroy of the Liang-kiang provinces as to the advisability of constructing an electric or other tramway in the city of Nankin. All steamers coming to the city at present have to anchor at Hsiakuan, a small village on the river bank, about half a mile outside the city wall, and five or more miles from the crowded business portion of the city. Within the last few years a well-made macadamised road has been completed over nine miles in length, but the only means of transportation is by donkeys, horses, jinrickshas, or very poor and expensive carriages. Chinese desiring to leave Nankin for Shanghai, or *vice versa*, are obliged to spend more for their fare from Nankin to Hsiakuan than for the 36 hours' steamship journey from Hsiakuan to Shanghai. The viceroy doubts that an electric line could be made to pay, but he seems impressed with the idea of tramcars drawn by Chinese ponies, which can be purchased very cheaply. Mr. Gracey suggests that the matter be placed before such manufacturers as may be interested, in order that estimates may be prepared which can be placed in the hands of the viceroy. The population of Nankin is about 300,000, and the vice-consul considers that a properly conducted tramway under modern management would pay. Five years ago there were practically no roads in Nankin, all conveyance being by animals or wheelbarrows. Now many good roads have been completed, and others are in process of construction.

THE WORTHING MOTOR OMNIBUS COMPANY, LIMITED, was registered on March 15 with a capital of £10,000, in £1 shares. Objects: to acquire the business carried on at Worthing as the Worthing Motor Omnibus Company, to adopt an agreement with the vendors, and to carry on the business of motor omnibus proprietors, etc. No initial public issue. Registered office, 6, Bath Place, Worthing.

LEEDS TRAMWAY FINANCE.

The financial year of the Leeds Corporation, which closed on the 25th ult., shows that the receipts of the Tramways Department for the twelve months have been £295,000, an increase of about £17,000 on the previous year. Such a substantial increase in the takings proves, says *The Yorkshire Post*, that the policy of extending the tramway system to practically every part of the city was a wise one for, although the mileage is practically the same as it was two years ago, the past year's increase is nearly £2,000 more than for the year 1903, when the increase reached £15,221. The past year's figures are interesting as showing not only that there will be a very substantial profit—in spite of the depression of trade—but also that the cheapening of fares in many directions has been accomplished without any financial loss.

Of a total of 64,223,666 passengers, 4,781,417 paid a halfpenny, 50,778,052 a penny, 1,424,136 three halfpence, 6,150,880 twopence, and 1,089,181 threepence. During the preceding twelve months the total was 60,739,234 or 3,484,432 less fares. The average receipts per mile amount to just over tenpence per mile—a slight decrease on the preceding year—but with an increase on the gross takings of about £18,000 it is hoped that when the other side of the account, namely, the expenditure, is made out, the balance of profit will be nearly, if not quite, as great as it was a year ago, when the sum of £52,000 was handed over to the relief of the rates, after all necessary allowances for maintenance, depreciation, interest, and sinking fund charges had been made. The work of the system for the past three years is thus shown:

	1904-5.	1903-4.	1902-3.
Receipts	£295,000	£277,655	£262,433
Mileage..	7,000,000	6,091,437	5,773,651
Passengers carried	64,223,666	60,739,234	57,239,779
Receipts per mile	10d.	10·94d.	10·90d.

It should be made clear that the tenpence indicating the average receipt per mile for the year just closed is only approximate, and that it has not been worked out to a fraction or decimal, as in the other instances. It is, however, expected to be upwards of 10d., although a little less than in the previous year.

THE ELECTRIC TRAMWAY AND RAILWAY EXHIBITION.—Over 140 firms have now secured space for this exhibition, which opens on July 3. Among the patrons are the Lord Mayors of Birmingham, Leeds, Liverpool, Manchester, and Sheffield, the mayors of practically all the important corporations working tramways, and the chairmen of the leading tramway committees. All indications point to an exceedingly interesting and useful exhibition.

LIVERPOOL-SOUTHPORT RAILWAY.—March 22 was the anniversary of the opening of the electrified line of railway between Liverpool and Southport. A frequent and regular service of electric trains has been maintained through the year, with but little interruption. An arrangement has been lately made under which passengers may book from the Dingle station, the southern extremity of the Liverpool overhead railway, to Southport, or *vice versa*. This through working was made possible by the connecting of the two lines at Seaforth, an important improvement which has been effected within the last twelve months.

TRIAL TRIP ON THE METROPOLITAN RAILWAY.—A trial trip on the newly electrified Underground Railway took place early on March 21 over the Metropolitan section of the Inner Circle. A fully equipped electric train ran from Baker Street, via Edgware Road, to South Kensington, then back to Baker Street, continuing by King's Cross and Moorgate to Aldgate, afterwards returning to the starting place. Everything passed off satisfactorily, and in all probability the public will have an opportunity of testing the new electric service in the course of a few weeks.

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LONDON COUNTY COUNCIL (TRAMWAYS) BILL.

The Speaker's Casting Vote.

In the House of Commons on the evening of April 3, the long-expected debate took place on the motion to instruct the Select Committee on the London County Council (Tramways) Bill to omit from the measure the proposals to connect the present Westminster and Blackfriars termini by a line across these bridges and along the Victoria Embankment. This line also would have branches turning into the authorised tramway-subway at Waterloo Bridge, thus providing through tramway communication between South and North London by way of the subway line on to the North Metropolitan tramways. Members of Parliament had been vigorously circularised both by supporters and opponents of the scheme, and, as in previous years when similar proposals had been discussed, there was a large attendance.

Mr. C. A. Whitmore (Chelsea) moved the instruction to the Select Committee to omit from the bill these proposed tramways. He said that in 1903, and again last year, these proposals were rejected by majorities of the House, so that the instruction would merely re-affirm the decision at which the House had arrived on former occasions. He was profoundly impressed with the importance, in the interests of the working classes on both sides of the Thames, of providing the cheapest, speediest, and most direct means of communication; but it was because he believed the bill would not provide such means of communication that he proposed the instruction. A tube railway was approaching completion which would start from the Elephant and Castle and run to Charing Cross and Baker Street; another line would proceed north from Charing Cross to King's Cross; and there was already communication from Blackfriars northwards. Under these circumstances, he did not think that there could be any great difficulty in the near future of giving to the working classes from South London the communication they desired. A Commission was sitting on the subject, which he was sorry had not reported. (Ironical Opposition cheers.) Surely until it did report they were in the same position as they were last year, and it was premature for them to sanction these new tramways. He could not help appealing to the artistic sense of the House. (Ironical Opposition cheers.) London was gradually becoming a city of beauty, and the centre of that beauty must always be in the region between the towers of Westminster and of St. Paul's. If they were to pick out of London a district into which they would not thrust unnecessarily an alien sweep of continuous traffic it would be this particular district, and he hoped hon. members would vote for the instruction.

Sir F. G. Banbury (Peckham), who seconded the motion, also maintained that they should wait till the Royal Commission on London Traffic had reported. He believed there was neither need nor demand for a tramway along the Embankment, and he suggested that if constructed it would compete with the fleet of steamers which the London County Council were about to place on the Thames at a cost of £350,000. Surely an ordinary business man would wait to see the result of the working of the steamers before putting a line along the shore to compete with them. He could only arrive at the conclusion that the London County Council had not sufficiently considered the interests of the ratepayers. Of course it might be argued that there should be a line from north to south to meet the underground tramway which in course of time might be running to the Savoy. That tramway had not, however, been completed, and there was no reason to be in a hurry until the Royal Commisson on Traffic had reported. He did not think that there was any traffic down the Embankment, but he believed that there was traffic over the bridges, and this Bill would simply mean that passengers would be able to get out on that side of the bridge instead of on the other. The police evidence was very strong about the danger of congestion which would be the result of bringing the trams over Blackfriars Bridge. If, however, the Royal Commission reported in favour of this tramway, his opposition and that of those who agreed with him would cease.

Mr. R. K. Causton (West Southwark) urged the House to reject the motion. In these times of driving competition, London could not be turned into a pleasure ground. The Embankment was not erected for purposes of luxury, but for the purposes of the ratepayers of London, who, as a whole, had paid for it and were entitled to use it. He did not think the trams would do any harm to the motor omnibuses, because the latter would serve the purpose of feeding the trams. In South London all the Corporations, including that represented by the hon. member for Peckham (Sir F. Banbury), were in favour of the Bill, and, as a South London member, he said that the people of London were entitled to the use of the Embankment (hear, hear). As an illustration of the need for the line, he mentioned that at present between the hours of 4-15 and 8-15 in the afternoon 30,000 people found their way to the tramway cars at the Blackfriars terminus. There was a similar traffic in the opposite direction in the mornings.

Mr. B. L. Cohen (East Islington), said that he intended to vote against the instruction, though on previous occasions he had supported it. (Hear, hear). He had never opposed these tramways because he thought they would be ugly. He would vote against the instruction because he was not willing any longer to be kept back by the only consideration which had influenced him, namely, the long-promised but never-appearing report of the London Traffic Commission. It seemed to him the Embankment was of all thoroughfares the most adapted for a tramway.

Mr. John Burns (Battersea), said that representations had been made against the scheme by certain omnibus companies, but these should not greatly influence the House. Tube railways were not so popular as they were expected to be, nor were they healthy. Neither tube railways nor motor omnibus were so cheap, so clean, or so speedy as electric tramways. An under-river passage was not possible, it would cost a million of money, and it would mean a dip from Kennington Lane to the Gaiety Theatre or Southampton Row. He could understand objection on æsthetic grounds if these tramways were to be iron monstrosities like the New York elevated railway; but cars would be worked on the conduit system, they would be inoffensive in appearance, advertisements being altogether dispensed with. Motor omnibuses were longer and wider than tramway cars and were dearer and dirtier. This tramway would not compete with the steamboats, and, if the House sanctioned the scheme, the tramways at Westminster Bridge could be connected with the tramways at Blackfriars Bridge within a month. All sections of the London County Council were in favour of this scheme; the City, who were formerly very hostile, had only rejected it by one vote, all the London borough councils were in favour of it, and in 15 days 110,000 signatures had been obtained to a petition in favour of the scheme If the tramways were brought over the bridges and a circular route was formed the crushing that now went on at the terminus on the Surrey side of Westminster Bridge would be avoided. Westminster Bridge was wide enough—86 ft. between the parapets—and the width of the Embankment varied from 80 ft. to 110 ft. There was absolutely no reason why the tramways should not go over the bridges, and he appealed to hon. members to have regard and consideration for the interests of the poor.

Mr. W. L. A. Burdett-Coutts (Westminster) stated that the Westminster City Council, which was the only borough council directly affected, was unanimously opposed to the proposal. It had not petitioned against it because the County Council had taken care that the Westminster Council should not have a *locus standi*. He maintained that for the House to take this matter out of the hands of the Traffic Commission, and to settle the most important part of the question that had been committed to their consideration would be an absolute negation of the whole function of a Royal Commission. (Hear, hear.) The development of the motor omnibus had an important bearing on the question of London traffic. Those who looked for a solution of the difficulties of locomotion to a combination of tubes for long distances and omnibuses for short distances were fortified in their views by the invention of the motor omnibus. Such a system would not place the locomotion of London and the field of employment which it involved in the hands of a central authority, but would leave it open to private competition.

Sir J. C. Dimsdale (City of London) opposed the bill, and said that it was a direct infringement of the rights of the city. The traffic over Blackfriars Bridge was such that not a single inch could be given for a tramway.

The House then divided, when there voted;

For the instruction	171
Against	171

There being thus a tie, it rested with the Speaker to give his casting vote. He announced that in order to allow of the bill going before a Select Committee, and to permit of further discussion of the subject, he would record his vote against the instruction.

The instruction was accordingly rejected, and the bill will come on for consideration by a Select Committee.

CLEAN CARS FOR AMERICAN TRAMWAYS.

American street railway managers have been accustomed to disregard certain minor details of management which in this country are considered to be of importance, but there are indications that the public will soon insist on greater attention to their comfort. It is, for instance, reported that the cars on the Scranton Avenue line of the Cleveland Electric Railway Company were stopped for two hours recently because a motorman and conductor attempted to take out a street car that did not meet the standard of cleanliness which the city "health officer" is putting in force. Recently the "health officer" started a crusade against dirty street cars, and has since had his deputies inspecting the sanitary condition of the cars. It was ordered that the cars be scrubbed at certain times and a standard of cleanliness necessary to health maintained. The health board is now considering an ordinance to limit the number of passengers carried in each car. It will be interesting to learn how the Cleveland public submit to this latter requirement, as hitherto they have enjoyed the privilege of boarding the first car that came along, no matter how many passengers it might contain. The old American street car rule "always room for one more" is apparently in danger of rational amendment.

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LIVERPOOL CORPORATION TRAMWAYS REPORT.

The annual report on the working of the Liverpool Corporation Tramways for 1904, by Mr. C. R. Bellamy, A.M.Inst.C.E., the general manager, has just been issued, and like its predecessors it is a most interesting document. In addition to the mass of details, which are of great value to all concerned in the operation of tramways, the book contains a number of diagrams showing the course of the traffic at various times, and a map showing the routes in colours. The abstract which here follows by no means exhausts all the points of interest in the report.

Routes, Stages, and Fares.—Additions and Alterations.

Hatton Garden—Seaforth Route.—On January 14, 1904, the Tramways Committee authorised the institution of a quarter-hourly service in the early morning and evening between Hatton Garden and Seaforth, on a representation that such accommodation was necessary for dock labourers. This route was opened on January 20, and tried experimentally for two months, during which the average car-mile earnings amounted to 4·756d., the total receipts to £279 18s. 4d., and the total expenditure to £539 14s. 3d., showing a loss over the period referred to of £259 15s. 11d., or at the rate of £1,688 13s. 5d. per annum. The committee, in consideration of these facts, discontinued the service on March 30, 1904.

Smithdown Road—Park Lane Service.—Under resolution of the City Council of October 29, 1903, the terminus of the Smithdown Road-Park Lane route was extended from South Castle Street to the Pier Head. The committee have from time to time considered reports of the general manager, and come to the conclusion that there was only a reasonable requirement for the few hours during the morning and evening to which the service was limited, but the City Council ordered that there should be a continuous quarter-hourly service, and this has been kept in force. The average car-mile earnings for the year 1904 amounted to 8·25d., the total receipts to £7,272 14s., and the expenditure to £8,281 9s. 6d., showing a loss of £1,008 15s. 6d. for the year.

Everton Church and Pierhead Route.—On December 11, 1903, the Tramways Committee ordered the discontinuance of the above route, but this decision was reversed by the City Council on January 1, 1904, when it was decided that the service should be continued until the provision of the Everton service *via* Everton Road was considered and dealt with by the committee. The car-mile earnings for the year 1904 averaged 7·84d., the total receipts amounted to £4,737 17s. 3d., against an expenditure of £5,682 12s. 3d., showing a loss of £944 15s.

Extension of Stages.—On the Garston and Seaforth route the 2d. stage between the Pierhead and Aigburth Vale has been extended to Mersey Road, and the penny stage from Upper Warwick Street to Aigburth Vale to Mersey Road, and the penny stage on the Litherland route from Delta Street to Wolsey Street has been extended to Lightbody Street.

Through Bookings St. Helens, Prescot, and the Pierhead.—The agreement with the South Lancashire Tramways Company for through booking between St. Helens, Prescot and the Pierhead was completed on July 21. A clause in the agreement provides that a reduction of fares between Sheil Road, Prescot and St. Helens shall come into operation as soon as the company reduce their fares between Knotty Ash, Prescot and St. Helens. Through booking at the reduced fares came into operation on May 24, 1904, and the following comparative statement shows the receipts and average car-mile earnings from that date to December 31 as compared with the corresponding period of 1903:

	1904. 7 Months.	1903. 7 Months.
Receipts	£33,542 18s. 7d.	£32,017 5s. 9d.
Average earnings per car mile	1s. 0·71d.	11·96d.

Stages and Fares.—At the meeting of the City Council on September 14, 1904, following a discussion on a notice of motion recommending the adoption of universal penny fares, the general manager was instructed to report upon this subject. The questions of halfpenny fares, universal penny fares, and fares for workmen were fully dealt with. It was shown that the general fares in Liverpool are lower than are provided under statute for workmen, and that the charge per passenger mile is the lowest in the country. The committee decided to recommend no change in the present stages and fares, excepting to adopt 1½d. stages, and the action of the committee was unanimously approved by the City Council.

Official Hand-book and Guide.

The official handbook and guide was placed on sale to the public on the cars, at the cash offices, and central tramway offices on April 5 last, since which date 71,948 copies have been sold at 1d. each.

Wheels.

In the joint report to the Tramways Committee on July 15, the engineers and general manager stated:

"The wheels of the German cars, which were the first to be used in Liverpool in 1898, were steel tyred, and the wheels of the American cars which followed were chilled cast iron. The steel tyres 'spread' in running, became loose and out of gauge, and were ultimately abandoned in favour of the chilled wheel, which was giving much better results on the American cars. The British manufacturers commenced the production of special steel tyres for tramcars about 1900, when their experimental use in competition with chilled wheels began. These experiments were carefully watched, and in May, 1902, a number of selected tyres were placed in service in Liverpool, and later it was considered desirable to try tyres of all the representative makers. Fifty-two of the cars are now fitted with steel-tyred wheels, none of which have yet worn out, and, therefore, final figures cannot be quoted. Very divergent results have, however, been obtained, the mileage per unit of wear varying to the extent of 50 per cent., indicating the importance of selecting tyres of suitable composition. As a result of the experiments carried out for the last two years, a steel-tyred wheel is now being assembled and finished at Lambeth Road Works, which will cost 50 per cent. less than the price at which such wheels can at present be bought, and which it is believed will afford a life considerably in advance of the average of these wheels, which may be estimated at 60,000 miles, the average mileage of chilled wheels in Liverpool being 35,000. It is hoped that on trial this new wheel will be found suitable for general adoption."

Since the date of that report over 100 cars have been fitted with new wheels, which are giving satisfactory results, and the work of general equipment is proceeding.

Covers for Upper Decks of Cars.

The total number of cars fitted with top covers and in service to date amounts to 317, out of a total of 350 the committee have ordered to be completed. As showing the effect of the top cover, it may be pointed out that the average maximum number of cars in service for 1904 was 398, as against 407 for 1903, while the passengers carried increased by 3,585,429.

Lifeguards and Fatalities.

The Liverpool plough guard has satisfactorily maintained its reputation for preventing persons getting under a car. Although during the year, 123 people fell in front of the cars or were knocked down, and passed under the platform they were all sheered clear, only three cases of fracture occurring. Six pedestrians were killed by being struck by cars, or 1 in 19,440,444 passengers carried. The number of persons who met their death in Liverpool through vehicles other than tramcars during 1904 amounted to 30. The ratio of fatalities to passengers carried on the railways, according to the most recent Board of Trade returns, amounts to 1 in 1,030,917.

Establishments.

Lambeth Road Works.—4,504 cars have been sent into the works for ordinary repairs, which shows an average running of 2,793 miles in each case. In addition, the following special work has been carried out in connection with the cars, viz: 145 cars have been sent in for the usual periodic examination and thoroughly overhauled and refitted where necessary throughout, and the whole stock of cars is in first-class condition. 225 cars were equipped during the year with the latest type of top cover, making a total of 317. The whole of the cars in service have now had the signal bells changed to the improved position on the canopy hand-rail. During the year over 22 tons of brass, copper, etc., castings were turned out by the brass foundry. The total number of men employed at these works on December 31, 1904, was 475, including the building staff, dealing with the maintenance and minor alterations to buildings.

Electric Car Depôts.

There are now five car depôts in full service, the Litherland depôt having been opened on October 18, 1904, for the accommodation of 44 cars operating the Bootle routes. Various alterations and additions have been carried out during the year.

New Tramway Offices.

The purchase of the site for new tramway offices in Hatton Garden was completed on July 20, and the entire site came into the possession of the Corporation on December 31. The work of excavation and foundations has been placed under contract with Messrs. Tomkinson and Sons, who are proceeding with the work. The committee have given close consideration to the detail plans and elevations of the new offices, prepared by the Corporation surveyor, and have finally adopted plans which have been approved by the City Council. The requirement for new office accommodation is becoming extremely urgent, as the lease of Pudsey Street depôt expires on March 25, 1906. The administrative department is now housed in four establishments, viz.: Sir Thomas Street, Pudsey Street, Hatton Garden, and Cumberland Street, which involves great inconvenience, and until the new offices are available it seems inadvisable to attempt to deal directly with compensation claims.

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Overhead Equipment.

During the year the total number of emergency calls in connection with the overhead equipment amounted to 558. These calls are exclusive of 65 for the breakdown wagon, dealing with obstructions caused by vehicles of various descriptions having broken down on tramway tracks in different parts of the city, and requiring to be removed to facilitate tramway traffic. In every case the work in connection with the emergency calls has been carried out expeditiously, and with a minimum interruption to traffic. During the six days ending April 18 the whole system was operated without an emergency call. The maintenance and renewal of the overhead equipment is at present carried out by a staff consisting of an assistant electrical engineer, district works superintendent, 10 linesmen, 3 assistant linesmen, and 28 drivers, labourers, etc. This department has in service six tower wagons, one pole wagon, one breakdown wagon, and one reel wagon.

The cost of maintenance and renewal of overhead equipment during the last four years has been as follows:

1901	£8,955 3 6	1903	£4,672 17 1
1902	£6,223 14 9	1904	£4,808 19 11

The slight increase in the cost of upkeep as compared with 1903 has been brought about in consequence of the fixing of additional suspensions to all the section insulators. The connections to these have been found to be the weakest part of the system, and the cost of carrying out the necessary strengthening has been charged to revenue.

Electrical Energy.

The total electrical energy used during the year 1904 for haulage and lighting of cars, etc., was as follows:

Liverpool	18,979,133 Units.
Bootle	1,066,496 „
Total	20,045,629 Units,

as against 17,978,718 units for the year 1903, an increase of 11·49 per cent.

The total cost for energy during the four years and the price paid per unit have been as follows:

	Total.	Per Unit.
1901	£72,352 16 10	1·2d.
1902	£82,752 15 4	1·2d.
1903	£80,956 4 5	1·098d.
1904	£94,937 0 11	1·159d.

Stock of Cars.

The stock of cars on December 31, 1904, was as follows:

No. in Stock.	Particulars.
15	Single-deck German motor cars, with trailers.
12	Single-deck cars of the American type, with side entrance.
3	American cars, fitted with upper decks and reversed staircases.
113	Double-deck single truck motor cars, with ordinary type of staircase.
76	Double-deck single truck motor cars, with reversed staircase.
275	Double-deck single truck motor cars, fitted with reversed staircase and improved roof covering.
Total .. 494	

Traffic.

The subjoined comparative statements show the percentage increases over the years 1903 and 1897 respectively, the latter being the last year of the company's management, and the passengers carried, mileage, and receipts for year ended December 31, 1904, together with the figures for the seven preceding years:

The increase for the year 1904 over 1903 is as follows:

Passengers	3·2 per cent.
Receipts	3·1 „

The increase for 1904 over 1897, the last year of the late company's control is as follows:

Passengers	203·68 per cent.
Mileage	102·33 „
Receipts	86·02 „

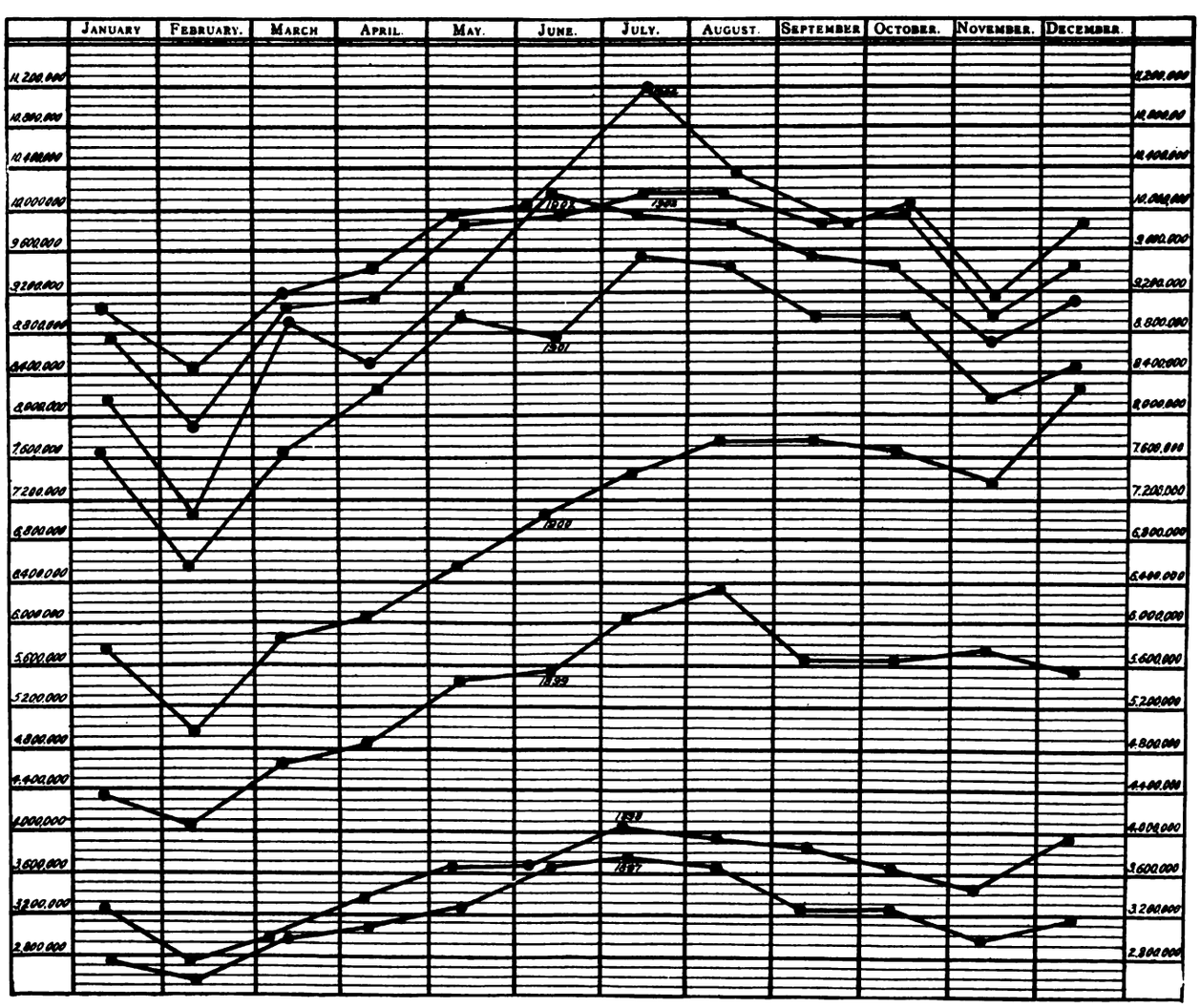

Chart Showing Number of Passengers Carried from 1897-1904.

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In connection with the laying of the foundation stone of the Liverpool Cathedral their Majesties King Edward VII. and Queen Alexandra visited Liverpool on July 19 last. During the celebrations connected with the visit, which lasted from Saturday until Tuesday, the traffic receipts amounted over the four days to £9,549 4s. 11½d., the number of passengers carried 1,990,220, while the maximum number of cars in service was 462.

The following return of tickets sold during 1904 shows the division of passengers over the various stages, viz.:

Value of Ticket.	Number Sold.	Percentage of Total.
1d.	104,275,892	89·39
2d.	11,555,252	9·90
3d.	646,371	·55
4d.	73,856	·06
5d.	3,933	·003
6d.	87,359	·07

	1904.	1903.
Clerical Staff.		
Male	60	53
Female—Cash Department	47	81
Ticket and Punch Department	33	
Car-sheds—		
Foremen, Mechanics, Brake, Trolley, and Controller Attendants, etc	96	94
Car Cleaners	207	201
Carriage Works—		
Mechanics	372	337
Labourers, etc.	78	74
Building Department—		
Mechanics' Labourers, etc.	25	17
Traffic Department—		
District, Motor, and Ticket Inspectors and Time Keepers	101	102
Drivers	679	664
Conductors	523	538

PASSENGERS, MILEAGE, AND RECEIPTS.

	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
PASSENGERS—								
Electrics	--	785,064	15,853,160	58,068,531	100,076,789	108,906,472	113,015,728	116,642,663
Horse cars	30,596,229	31,985,158	39,321,946	19,051,875	218,166	74,685	41,506	--
Omnibuses	7,812,855	9,001,812	8,596,344	5,247,552	813,825	354,428	—	
Total	38,409,084	41,772,034	63,771,450	82,367,958	101,108,780	109,335,585	113,057,234	116,642,663
MILEAGE—								
Electrics		53,197	1,473,750	5,584,357	10,771,461	11,705,425	11,724,097	12,166,419
Horse cars	4,674,009	4,736,103	4,758,652	2,571,163	46,247	16,534	10,741	
Omnibuses	1,338,573	1,490,458	1,368,144	945,346	152,355	68,856	—	—
Total	6,013,182	6,279,758	7,600,546	9,100,866	10,970,063	11,790,815	11,734,838	12,166,419
RECEIPTS—								
Electrics		£4,087	£77,145	£284,759	£463,164	£504,304	£524,321	£540,850
Horse cars	£239,399	250,975	234,756	105,212	717	278	147	--
Omnibuses	51,344	59,145	47,658	27,603	4,502	2,146	—	
Total	£290,743	£314,207	£359,929	£417,574	£468,383	£506,728	£524,468	£540,850

SPECIAL CARS.

The number of special cars provided during the year for various functions was 400, as against 420 for 1903. The number of passengers so carried was 44,705, as against 43,864 in 1903. The amount received was £234 5s. 3d., or an average fare per passenger of 1·257d., as against £234 0s. 11d., or an average fare per passenger of 1·280d. in 1903. The decrease in the number of cars is due to the discontinuance of the provision of special cars after midnight, and also to the fact that no special cars were provided during the Royal visit.

TRAFFIC IN CENTRE OF CITY AND AT IMPORTANT STREET INTERSECTIONS.

The number of cars arriving at and leaving the Pierhead on the different routes in the busy season is 5,800 per day, South Castle Street 992, and Old Haymarket 690, representing a total of 7,482 cars running in and out of the city per day.

Crossing St. George's Crescent	3,775
Passing the Town Hall	3,378
Crossing the Junction of Old Haymarket and Dale Street	3,404
Crossing the Junction of London Road and Lime Street	2,761
Crossing Paradise Street and Lord Street	3,969

LOST PROPERTY.

The number of articles of property found on the cars during 1904 was 22,203, compared with 15,516 in the previous year. As showing the extreme carelessness of passengers and the excellent method of dealing with lost property found on the cars it may be mentioned that on Tuesday, December 20, a passenger boarded a car leaving his handbag on the platform, the conductor being on top of the car. Another passenger did the same. The first passenger left the car and took the handbag owned by the second passenger. The bag left on the car was found to contain a number of cheques aggregating in value to £4,580. The bag and contents were at once sent to the lost property department and handed to the owner the following morning.

STAFF, ETC.

The present staff of the tramways department consists of the following, viz.:

General Manager
Traffic Superintendent.
Works Superintendent.
Assistant Electrical Engineer.
District Works Superintendent.
Depôt Inspector.
Chief Clerk.
Lady Superintendent of Ticket and Punch Department.
Lady Superintendent of Cash Department.
General Manager's Secretary.
Chief Traffic Assistant.
Chief Traffic Clerk

	1904.	1903.
Point Attendants, Signalmen, Labourers, Youths, etc.	115	124
Overhead Department—		
Linesmen and Assistants	13	15
Drivers, Painters, Labourers, etc.	28	23
Stable Department—		
Foremen, Horsekeepers, etc.	14	14
Miscellaneous—		
Provender Department	1	2
Tailors	5	4
Saddlers	1	1
Watchmen	3	1
Charwomen, Cleaners, etc.	8	
Total	2,409	2,348

During the year the Tramways Committee have granted day, relief, and assistant foremen at the car-sheds seven days' holiday per annum; the doorkeeper and night watchman at the central offices a fortnight's leave of absence, and the assistant doorkeeper and lift attendants one week's leave of absence per annum with full pay. The holidays granted drivers and conductors by the Committee in 1903 came into operation during the year, under which 927 men enjoyed five days' holiday with full pay.

TRAMWAYS BAND

This band now consists of 40 members, and is making very good progress under the conductorship of Mr. James Farrel, the bandmaster. During the year the services of the band have been requisitioned by the Parks and Gardens Committee in connection with music to the public in various open spaces and the parks.

UNIFORM CLOTHING.

The new type of uniform clothing, with red piping, and P. & O. cap, were issued throughout the service in May, and had the effect of considerably brightening up the appearance of the men.

DISUSED CLOTHING.

Sales of disused clothing to the poorer classes took place at the Pudsey Street depôt on 11 days throughout the year, but notwithstanding the fact that the whole of the sales were very prominently advertised, it became evident that the available market for the disposal of this clothing in this manner had been exhausted for the time being. Under the circumstances, the committee have felt compelled to revert to the ordinary method for the disposal of this clothing.

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Employees' Benefit Society.

The membership of this society is now 1,726, against 1,697 in the previous year. During 1904, sick allowance was granted for varying periods to 791 members, each receiving an average of £2 6s. 6d. 20 death claims were paid, of which 8 were members, and 12 members' wives. The statement of accounts for the year ended December 31 shows a total income of £3,386 19s. 9d., and a total expenditure £2,552 16s. 5½d., leaving a balance on the year's transactions of £834 3s. 3½d. The balance sheet shows the amount standing to the credit of the society on December 31 as £4,197 7s. 2d., of which £4,000 is invested in Liverpool Corporation Bonds, bearing interest from 3¼ to 3½ per cent. The question of a superannuation fund in connection with the society is still under consideration.

Social, Athletic and Thrift Society.

The membership of this society now stands at 1,646, the number having increased 6½ per cent. over last year. The balance sheet for the year ended December 31, shows the value of assets over liabilities to be £960 2s. 1d., in addition to the sum of £84 15s. 0d. standing to the credit of the Widow and Orphans' Fund. The receipts during 1904 amounted to £2,478 11s. 8½d., and the payments to £2,348 16s. 1¼d., leaving a balance of cash in bank and in hand of £129 15s. 7d. A number of social functions were held during the year. On 12th and 13th July athletic sports were held under N.C.A.A.A. rules at the Employees' Athletic Ground, Green Lane—prizes to the value of upwards of £100 being generously provided by members of the City Council. These sports were attended by over 10,000 people, members and wives or friends being admitted free. Considerable improvements in all the recreation rooms have been made during the year. In addition to the refreshment rooms which have been provided at Green Lane and Walton depôts, others have been equipped at Dingle and Litherland, and the one at Smithdown Road will be ready shortly, which will complete the equipment of the depôts in this direction. In all cases the attendants at the stalls are deserving widows of members who have died in the service.

The following is an analysis of the cost of working under electric traction for the year 1904, compared with the years 1903, 1902, and 1901, viz.:

	£	s.	d.	Cost per Car Mile, 1904. d.	Cost per Car Mile, 1903. d.	Cost per Car Mile, 1902. d.	Cost per Car Mile, 1901. d.
Maintenance and renewal of cars and fittings (including new lifeguards, ventilators, emergency boxes, signal bells, etc.)	42,721	18	2	·842	·775	·770	·855
Maintenance of tools and machinery	1,322	8	4	·026	·023	·032	·025
Maintenance of sundry stock	720	11	1	·014	·012	·018	·024
Repairs to sheds, etc. ..	1,799	0	11	·035	·035	·067	·079
Electrical energy—Haulage, lighting cars, etc...	94,937	0	11	1·872	1·657	1·696	1·612
Road & Traffic Expenses:							
Salaries—Wages to drivers, conductors, inspectors, etc... ..	121,204	18	1	2·390	2·490	2·441	2·428
Gravelling, etc... ..	1,404	9	3	·027	·035	·040	·055
Cleaning, etc., of cars ..	9,222	11	9	·181	·190	·201	·192
Cleaning and lighting sheds, etc	2,508	12	1	·049	·050	·049	·038
Lighting routes.. ..	150	6	4	·002	·003	·002	·002
Tickets and punches ..	2,029	12	10	·040	·047	·054	·056
Repairs, etc., of knee aprons..	44	9	1	·0008	·004	·001	·004
Licenses	426	12	6	·008	·008	·008	·007
Advertising, printing, and stationery ..	934	10	8	·018	016	·018	·024
Uniform clothing, bags, etc.	4,374	0	3	·086	·070	·085	·086
Sundry charges..	2,349	7	6	·046	·052	·061	·053
Maintenance and renewal of lines	25,119	4	1	·495	·432	·287	·227
Maintenance and renewal of electrical equipment	4,808	19	11	·094	·095	·127	·199
Acknowledgments for privilege of affixing rosettes	158	0	7	·003	·003	·003	·004
Rental of lines in Bootle..	5,857	11	5	·115	·119	·120	
General Charges, including rates and taxes, management and office expenses, compensation and law charges, etc ..	45,750	15	5	·902	·852	·804	810
Total	£367,845	1	2	7·256	6·978	6·884	6·780
Interest and Sinking Fund	108,717	7	8	2·144	2·188	2·089	2·096
	£476,562	8	10	9·400	9·166	8·973	8·876
Car mile earnings.. ..				10·67	10·73	10·34	10·32

The ensuing is a summary of the principal figures applicable to the Liverpool Tramways for the years 1902, 1903, and 1904 respectively:

	1903. £ s. d.	1902. £ s. d.	1904. £ s. d.
Capital expenditure to December 31, including purchase price of the horse undertaking and debt on the horse lines	1,832,977 9 11	1,863,485 1 5	1,916,257 14 11
Total revenue	517,935 5 0	531,483 14 10	557,888 13 10
Operating costs ..	339,810 19 8	341,463 9 10	367,845 1 2
Percentage of operating costs to total revenue	65 %	64·247%	65·9%
Gross profits	178,124 5 4	203,256 18 9	190,043 12 8
Percentage of gross profits to capital expenditure	9·7%	10·90%	9·9%
Interest & Sinking Fund	102,627 0 2	107,014 0 10	108,717 7 8
Balance	75,497 5 2	96,242 17 11	81,326 5 0
Divided as follows:			
Reserve, renewal, and depreciation ..	50,331 10 2	64,161 18 7	54,217 10 0
Transferred to Gen'r'l Rate Account ..	25,165 15 0	32,080 19 4	27,108 15 0
Total operating costs per car mile	6·884d.	6·983d.	7·256d.
Interest & Sinking Fund per car mile . ..	2·089d.	2·188d.	2·144d.
Total charges	8·973d.	9·171d.	9·400d.
Car mile earnings ..	10·34d.	10·733d.	10·67d.
Average fare per passenger ..	1·111d.	1·113d.	1·112d.
Average length of penny stage	2½ miles	2½ miles	2 miles 671 yds
Length of track ..	101 miles	103 miles	103 miles

TRAMWAY AND ELECTRIC RAILWAY LEGISLATION.

SECOND READINGS.—In the House of Lords, March 7: South Eastern and London, Chatham, and Dover Railways. March 9: Metropolitan Railway. March 13: Hastings Tramways, Wellingborough and District Tramroads and Electricity Supply. March 30: South Lancashire Tramways.

In the House of Commons, March 7: Wigan Corporation, London Council (Tramways), Baker Street and Waterloo Railway, Charing Cross, Euston, and Hampstead Railway, Edgware and Hampstead Railway, Great Northern, Piccadilly, and Brompton Railway (No. 1). March 13; Ulster and Connaught Light Railways. March 20: London United Tramways. March 21: North Eastern Railway, Great Western Railway (additional powers). March 28: Metropolitan Electric Tramways. March 29: London United Tramways (extension of time).

THIRD READINGS.—In the House of Lords, March 27: Metropolitan and District Railway; Tyneside Tramways and Tramroads.

ACCRINGTON CORPORATION.—The portion of this bill dealing with tramways was passed by a Committee of the House of Commons on March 14. The measure authorises the use of electric traction on the tramways and the construction of some short extensions of the lines. The Corporation will begin working the tramways on the expiry of the lease to the local tramway company in 1907.

BAKER STREET AND WATERLOO RAILWAY. On March 27 it was intimated to a House of Commons Committee appointed to consider this measure, that the bill was now unopposed.

BIRMINGHAM CORPORATION.—This bill came before a Committee of the House of Commons on March 21, when it was intimated that the opposition had been withdrawn, and the measure was accordingly sent to the Committee on Unopposed Bills. Thus one of the most extensive tramway schemes of the year has the advantage of going through Parliament without opposition.

BLACKPOOL, ST. ANNE'S, AND LYTHAM TRAMWAYS.—Intimation was made to the House of Lords on March 10 that the promoters of this bill did not intend to proceed further with it. Non-compliance with Parliamentary standing orders had previously been reported. This measure, among other things, proposed to give the local tramway company compulsory running powers over certain of the tramways of Blackpool Corporation, and its withdrawal obviates any contest in Parliament analogous to that which took place last year over the Tyneside Tramways Bill.

BUENOS AYRES GRAND NATIONAL TRAMWAYS COMPANY. Official intimation was made on March 25 that the promoters of this bill do not intend to proceed further with the measure It was a bill

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to amalgamate the Company with another Buenos Ayres Tramway Company, and to make various financial arrangements for the purpose.

CHARING CROSS, EUSTON, AND HAMPSTEAD RAILWAY.—This bill was passed by a Committee of the House of Commons on March 27. The only point in dispute was as to acquiring more of the subsoil under the forecourt of the South Eastern Railway's Charing Cross Station, for the underground station there of the promoters' railway. The provision was granted, subject to a stipulation that the staircase from the entrance in the forecourt to the station below should be 8 ft. wide instead of 6 ft. 9 in. as originally proposed in the bill.

EDGWARE AND HAMPSTEAD RAILWAY.—A Committee of the House of Commons met on March 21 to consider this bill, but intimation was made that the opposition to it had been withdrawn. It was accordingly referred to the Committee on Unopposed Bills.

GLASGOW CORPORATION (TRAMWAYS CONSOLIDATION).—The Chairmen of Committees of the two Houses of Parliament have reported that the standing orders not complied with in respect of this Provisional Order application be dispensed with and the Order allowed to proceed, provided that the powers to construct tramways Nos. 1 and 3 and part of tramway No. 2, to which the promoters have not obtained the consent of Partick Town Council, be struck out.

GREAT NORTHERN PICCADILLY AND BROMPTON RAILWAY (No. 1). This bill came before a House of Commons Committee on March 27. Its main object is to authorise the construction of an extension of the Company's authorised line from the Strand, under the Thames, to Waterloo Station. Mr. C. T. Yerkes gave evidence for the promoters, and stated that the Underground Electric Railways Company of London were prepared to construct the new line and find the necessary capital. The estimated cost would be £329,000, and the railway would be a single line and would be worked on the shuttle system. The fare from the Strand to Waterloo would be twopence. On March 28 Mr. Yerkes was again examined, and said that the additional cost of building the railway as a double line would be £120,000. His idea was that, if in future the traffic required it, another bill should be promoted for doubling the line. After other evidence the Committee announced that they could not consent to a single line, but they were willing to meet the wishes of the promoters if the latter would submit a scheme for double tunnels. On March 29 the promoters submitted a clause providing that the railway should not be opened unless and until a second tunnel had been constructed, so as to provide a double line. The Committee approved the clause and passed the bill.

GREAT WESTERN RAILWAY (NEW RAILWAYS).—A House of Commons Committee on March 29 began consideration of this Bill, which proposes the construction of additional lines in various districts. The only one of these of special interest to our readers is a line from the Company's existing railway at Ealing Broadway to Shepherd's Bush, a distance of 4½ miles. The estimated cost is £430,000, and the objects in view, it was stated, were to enable the Company to make greater use of the West London Extension Railway, and to relieve the traffic on the line between Acton and Paddington. The Company contemplated developing Ealing as a junction or exchange station similar to Willesden, Clapham Junction, etc. At Shepherd's Bush it was proposed to make a subway for foot passengers connecting with the Central London Railway. The Company owning the latter railway supported the scheme. It was mentioned that it was not the present intention to electrify the new line. The Metropolitan Railway Company and the London County Council opposed the scheme. The Committee passed the bill on March 31.

HAMMERSMITH CITY AND NORTH EAST LONDON RAILWAY.—The Standing Orders Committee of the House of Commons decided, on March 7, that in the case of this Bill the standing orders not complied with should not be dispensed with. The Bill is, accordingly dead. When the Bill was before the Examiner it was stated that the deposit money was not lodged. The Bill was a revival of the through route scheme, which failed to pass in the Session of 1903.

HASTINGS TRAMWAYS.—On March 10 the Standing Orders Committee of the House of Lords reported that this bill, in regard to which non-compliance had been announced, should be allowed to proceed, provided that clause 7 be struck out, unless the consent of the Corporation of Bexhill is proved before the Committee on the bill. Clause 7 is the one which seeks authority to construct new tramways to a length of 1 mile 44 chains. The other provisions of the bill for extension of time for the completion of authorised lines, etc., are not affected.

LONDON COUNTY COUNCIL (TRAMWAYS.)—The discussion in the House of Commons on the motion of the omission from this Bill of the proposed lines across Blackfriars Bridge, along the Victoria Embankment, and across Westminster Bridge was set down for April 3, at the evening sitting. Three members of Parliament—namely, Mr. Whitmore, Sir F. Banbury, and Mr. Alban Gibbs—gave notice of the motion.

METROPOLITAN RAILWAY.—On March 15 intimation was made to the House of Lords that the opposition to this bill had been withdrawn.

MEXBOROUGH AND SWINTON TRAMWAYS (EXTENSION OF TIME).—Intimation was made to the House of Lords on March 10 that the opposition to this bill had been withdrawn.

OLDHAM AND SADDLEWORTH DISTRICT TRAMWAYS.—On March 7 intimation was made to the House of Lords that the opposition to this bill had been withdrawn.

SOUTH EASTERN AND LONDON, CHATHAM, AND DOVER RAILWAY.—On March 21 intimation was made to the House of Lords that the opposition to this bill had been withdrawn.

SWANSEA CORPORATION.—This Bill, which among other things sought to empower the Corporation to purchase the lines of the Swansea Tramways Company, came before a Committee of the House of Commons on March 21. The Court of Chancery had decided in a suit between the Corporation and the company that the former could only buy the lines in parts as they fell in at the end of successive leases, and the net result was that the last of them could not pass into the hands of the Corporation till 1993. The Corporation now urged that, though the drafting of the clause in the company's Act passed in 1882 was faulty and had been interpreted as above, the real intention of the parties was that the lines should be purchasable in 21 years from the date of completion. That period would expire in February next. It was contended for the company that the Corporation could not ask Parliament to set aside the decision of the Court. The Committee decided that the preamble of the Bill, so far as the tramway part of it was concerned, was not proved.

WELLINGBOROUGH AND DISTRICT TRAMROADS AND ELECTRICITY SUPPLY.—The Standing Orders Committee of the House of Lords on March 10 reported that this bill, in regard to which non-compliance with standing orders had been found, should be allowed to proceed, provided that the powers to construct tramways 1 and 2 be struck out, unless the consent of Northamptonshire County Council and Wellingborough Rural District Council is proved before the Committee on the bill. These were the only new lines proposed, but they only amounted to 7 chains. The bill has a number of other provisions.

WEMYSS TRAMWAYS.—Commissioners under the Private Legislation Procedure (Scotland) Act, with Lord Killanin as chairman, sat in Edinburgh on March 24 and succeeding days to consider the above draft Provisional Order. The promoter is Mr. R. G. E. Wemyss, and the object is to obtain powers to construct electric tramways from Kirkcaldy to Leven, Fifeshire. The opponents were the North British Railway Company and the Kirkcaldy and Dysart Waterworks Commissioners. Mr. McClure, for the promoter, said that the tramways would pass through the Wemyss estate, which was full of coal and developing rapidly. The population of the towns and villages affected was 63,400. A large part of the district was without any regular means of communication, and the railway service for the other part was poor. All the public bodies concerned were in favour of the scheme. Mr. Wemyss gave evidence in support of the bill, and said that the line would not compete with the North British Railway. It was only proposed to carry goods for local purposes. Local evidence having been heard in support of the Order, Mr. McClure stated that he was willing to insert a clause prohibiting the carriage of coal or goods on the tramways to the harbour of Fife for shipment. Mr. Clyde, for the railway company, said he could not agree to the tramway having power to carry more than ordinary passenger and parcel traffic. Mr. Stephen Sellon, C.E., was examined in support of the scheme, which, he said, was for a combination of a tramway and a tramroad, and it was usual to give power to carry goods. The line would cost £52,000, and the traffic receipts from passengers were estimated at £12,000 per annum. The working expenses were put at £7,200, and after paying 5 per cent. on capital there would be a surplus of £2,200. The evidence for the railway company included that of Mr. Balfour Browne, K.C., who testified as to the practice of Parliamentary Committees on tramway bills. Mr. W. F. Jackson, general manager of the North British Railway Company, said that the tramways would be in direct competition with the railway alike for passenger, goods, and mineral traffic. Agreements existed between the railway company and Mr. Wemyss, under which the latter was restricted from constructing new railways or docks in competition with the existing works. Mr. Wemyss was also one of the coalmasters who signed an agreement for 21 years not to construct new railways in Fife, in consideration of the railway company constructing docks at Burntisland.—On March 27 the Commissioners passed the Order, and limited the amount of goods to be carried to 500 lb. per consignment. Kirkcaldy Waterworks Commissioners sought special protective clauses in regard to possible electrolysis of their pipes, but these were substantially refused, after it had been pointed out that the existing Board of Trade regulations were sufficiently stringent.

WHITECHAPEL AND BOW RAILWAY. It was officially announced on March 10 that this bill is unopposed.

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LONDON ELECTRIC POWER BILLS.

A Select Committee of the House of Lords, presided over by Earl Camperdown, commenced consideration on Friday, March 17, of the Administrative County of London and District Electric Power Company Bill, the first of a group of nine London electric supply and power bills which have been referred to them for consideration. There are a very large number of petitions against the whole of the bills.

The Hon. J. D. FITZGERALD, K.C., in the course of his opening speech for the Administrative County of London Bill, mentioned that in that area there were 30 local authorities and 21 companies supplying electrical energy. These owned 62 generating stations. The price which was ten years ago regarded as an average one was 6d. per unit, but this was absolutely out of the question at the present time. London undoubtedly required a power company, for at present there were something like 600,000 hands employed in the industrial centre, and the horse-power of manufacturing machinery there already amounted to 450,000 H.P. Of that only about 4 per cent. was at present supplied by the existing companies and local authorities. It was proposed to erect three generating stations, one on the south of the Thames at Greenwich, another nearly opposite on the north at West Ham, and a third at Fulham, and the capital proposed was £5,000,000 and the usual one-third borrowing powers. It was proposed, in the non-industrial area, to supply railway companies, tramway companies, canals, docks, and Government departments. When the existing railway and tramway companies in London adopted electricity as the motive power, they had in all cases been compelled to set up generating stations of their own, there being no company in existence to supply the necessary power economically. In this manner the Central London Railway, the Metropolitan and District Railways, and the London United Tramways Company had all to build separate generating stations. These companies now, of course, could not be expected to be customers of the new company; but there were numerous other underground railway schemes coming before Parliament, as well as the numerous suburban railway lines, carrying a large traffic. In this respect a large demand might be looked for. That these estimates were not merely the sanguine hopes of the promoters, but were based upon fact, was proved by what had taken place around Newcastle, where the North Eastern Railway Company and the Tyneside Tramways Company both took energy from the power company there. The promoters did not take powers for lighting in the non-industrial area in the ordinary sense. Counsel explained the bill in detail, and said that with regard to power supply not one of the existing electric supply authorities in the non-industrial area supplied the consumers which it was anticipated the new company would supply, viz., railways, canals, tramways, Government departments, etc. Concerning the industrial area, the promoters asked for no monopoly. Nearly all the petitioners opposed the breaking up of streets, but it was not the intention of the promoters to do anything against the wishes of the local authorities.

Mr. C. H. MERZ, consulting engineer to the promoters, gave evidence extending over several days, explaining that their main object was to supply energy to authorised distributors, and also generally to persons who carried on their businesses over large areas, such as railway and tramway companies, etc., who could not obtain their energy from one small local generating station. If all the manufacturers in London could be induced to take power from the promoters, it was estimated that by 1911 the demand would be 380,000,000 Board of Trade units per annum; and, in addition, assuming the present curve of increase was maintained, the lighting demand would be 298,000,000 units. As regarded traction, assuming that all the existing suburban lines were worked electrically, with the present speeds and present traffics, the demand in 1911 would be 552,000,000 units, making a total demand of 1,200,000,000 units per annum six years hence. These were maximum possible figures. The existing stations could not possibly deal with such a load. He estimated that in 1910 there would be a balance sufficient to pay a dividend of 6 per cent. on a capital expenditure of £2,000,000.

In cross-examination by Mr. Balfour Browne, K.C., on behalf of the existing companies and the promoters of the competing bills, the witness did not admit that there was going to be competition.

Mr. BALFOUR BROWNE: If a local authority, for instance, cannot supply as cheaply as you can, cannot you ask the Board of Trade to allow you to come in?—Yes.

That would be competition?—For power, yes.

On Wednesday, March 22, the Hon. C. A. PARSONS, F.R.S., was called, and he was followed by Mr. S. Z. DE FERRANTI, who agreed with the evidence and estimates of Mr. Merz.

Mr. BALFOUR BROWNE: Is it your idea that the present stations should supply up to their present capacity and then take from you?—Possibly.

Then the local authorities and companies will simply become the distributors of your electricity? I should not like to say that at the commencement.

But it will be at the end, and then you will have one gigantic monopoly?—Only the monopoly of cheapness.

On Thursday, March 23, evidence was given in support of the bill by Mr. VINCENT RAVEN, chief assistant mechanical engineer to the North Eastern Railway Company; Mr. GOODAY, general manager of the Great Eastern Railway; Mr. CUNINGHAM, general manager of the Central London Railway Company; Mr. GRIPPER, of Messrs Edmundson's Electricity Corporation; and a number of other witnesses, among them Mr. J. FALCONER, one of the promoters and chairman of the Mersey Railway Company, who said the main object of the bill was to supplement the existing means of supply in London as far as possible by co-operation with the present authorities.

On Monday, March 27, evidence was given by Sir Alex. Binnie on behalf of the promoters, and by Mr. A. Stenning, surveyor. The former said he thought the route of the ring main was one which, would tend to the minimum inconvenience. The streets most crowded with pipes and wires had been avoided to a large extent. The method proposed by the promoters would prevent the continual breaking up of the streets.

At the conclusion of the case for the promoters, Mr. R. NEVILLE, K.C., opened that for the opposition ou behalf of the following nine electric supply companies, which had presented a joint petition: Brompton and Kensington Company, Charing Cross and Strand Company, Chelsea Company, London Electric Supply Company, Metropolitan Electric Supply Company, St. James's and Pall Mall Company, South London Company, South Metropolitan Electric Light and Power Company, Westminster Company. He said his companies had expended some £8,000,000 upon their undertakings, and the contention he had to submit was that under the Electric Lighting Acts of 1882 and 1888 no monopoly was intended, but that competition should be allowed. The competition, however, was more or less of a defined character, namely, between holders of Provisional Orders. The competition threatened by the bill was not a competition which was in any sense the competition contemplated at the time of the passing of the 1882 Act, but one quite different and of a much more serious character. The promoters were asking to be placed on an entirely different footing to the present undertakers, and stated that by being allowed certain privileges they would be able to supply electrical energy at a very cheap rate. In fact, they asked to be made the spoilt children of the Legislature without regard to the expenditure of the shareholders of the existing companies. The dividends hitherto paid by all the electric supply companies in London had averaged just 4 per cent., and there were only 26 years of their period left unexpired. Having succeeded in placing the business on a very much better basis than hitherto, the companies were confronted with competition from a new company seeking to reap the benefit of all their exertions by asking for easier terms than had ever been granted before. There was no precedent for a power bill covering an area which was practically wholly provided with electrical supply.

On Tuesday, March 28,

Mr. J. H. CONACHER, general manager of the Metropolitan Electric Supply Company, was the first witness called, and, in the course of his evidence, said his opinion of the effect of the bill was that it enabled the promoters to pick and choose its customers. On the other hand, the London companies were only too anxious to secure every customer, and very seldom asked for the 20 per cent. guarantee which they were entitled to ask for in the non-compulsory area. With regard to the proposed supply under the bill to canals, docks, tramways, and railways, he maintained that so far as the two latter were concerned there was nothing in their Provisional Orders to prevent the present companies supplying them, even if the energy were used outside the district, but in order to clear the matter up there having existed a doubt concerning it—many London companies were including a clause in their power bills, which would also come before this Committee. With regard to canals and docks, there would be direct competition between the new company and the existing companies.

In cross-examination by the Hon. J. D. Fitzgerald, K.C., the witness mentioned that the Metropolitan Electric Supply Company did not supply any railway, tramway, canal, dock, etc., and only to a small extent, Government departments. It was not fair to compare the present works costs of the London companies with the proposed costs of the Administrative County of London Company, because the conditions would not be the same. The promoters were basing their costs upon a large tramway, railway, and bulk supply, and no such supply at present existed in London.

Mr. L. H. HORDERN, manager of the Westminster Electric Supply Corporation, also gave evidence.

Further evidence was given on Wednesday, March 29, Thursday, March 30, and Friday, March 31, one of the witnesses, Mr. Philip Dawson—of the firm of Messrs. Kincaid, Waller, Manville, and Dawson—expressing the opinion that he did not believe that in actual practice the promoters would get the load-factor they anticipated, especially if they did not get the tramway and railway load. There was very little probability of a tramway load, because all the existing tramway authorities had their own supply. Further, he had no confidence in outside sources of supply, especially for large quantities.

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LIGHT RAILWAY AND TRAMWAY PROMOTION (*Continued*).

Private Bill Procedure.—Part II.*

By Arthur P. Poley, B.A., Barrister-at-Law.

Notices by Advertisement.

The first step that promoters have to take is to give notice by advertisement stating the objects of their intended application, and the time at which copies of their bill will be deposited in the Private Bill Office. The Standing Orders of both Houses are identical. When powers are sought for the compulsory purchase of lands or houses, or compulsory user of the same, or for extending the time granted by any former Act for that purpose, or to amalgamate with any other company, or to sell or lease the undertaking, or to purchase or take on lease the undertaking of any other company, or to enter into working agreements or traffic arrangements, or to dissolve any company, or to amend or repeal any former Act or Acts, or to levy any tolls, rates, or duties, or to alter any existing tolls, rates, or duties, or to confer, vary, or extinguish any exemptions from payment of tolls, rates, or duties, or to confer, vary, or extinguish any other rights or privileges, or to impose on any lands or houses, or to render any lands or houses liable to the imposition of any charge in respect of any improvement, the notice shall specify such intention and shall also specify the company, person, or persons with, to, from, or by whom it is intended to be proposed that such amalgamation, sale, purchase, lease, working agreements, or traffic arrangement shall be made. The whole of the notice relating to the same bill shall, except as provided by Standing Order 9 (House of Commons), be included in the same advertisement, which shall be headed by a short title descriptive of the undertaking or bill, and shall be subscribed with the name and address of the person, company, corporation, or firm responsible for the publication of the notice.

The exception provided by Standing Order 9, is as follows:

"Except where the bill relates to lands or works situate in more than one county, where it is optional for the promoters to publish in each of such counties so much only of the notice as relates specifically to the lands or works situate in that county, together with the short title of the notice, and an intimation that the notice has been published in full and sent for publication in full to the *Gazette*."

The notices must furthermore contain a description of all the termini, together with the names of the parishes, town lands, and extra-parochial places, from, or, through, or into which the work is intended to be made, maintained, varied, extended, or enlarged, or into which any land or houses intended to be taken are situate, and where any common or commonable land is intended to be taken or used compulsorily, such notice shall contain the name of such common or commonable land (if any), and the name of any parish in which such land is situate, together with an estimate of the quantity of such common or commonable land proposed to be taken or used compulsorily, and shall state the time and place of deposit of the plans, sections, books of reference, and copies of the *Gazette* notice respectively with the Clerks of the Peace and Sheriff Clerks, and also with the following officers as the case may be. These are mentioned in Order 29:

(*a*) In the City of London, or any borough in England or Wales, whether metropolitan or other, with the Town Clerk of such city or borough.

(*b*) In any urban district in England or Wales not being a borough, with the Clerk of the District Council.

(*c*) In any parish in England or Wales having a Parish Council, with the Clerk of the Parish Council, or if there is no clerk with the Chairman of that Council.

(*d*) In any parish in England or Wales comprised in a rural district and not having a Parish Council, with the Chairman of the parish meeting and with the Clerk of the District Council.

(*e*) In any burgh in Scotland with the Town Clerk or Clerk.

(*f*) In any parish in Scotland outside a burgh, with the Clerk of the Parish Council.

(*g*) In any urban or rural district in Ireland, with the Clerk of the District Council.

When compulsory powers are sought for taking lands for the construction of a station for generating electricity, "the notices must set forth and specify the lands in or upon which it is to be constructed."

The notice must also specify "at what point or points, and on which side of the street or road it is proposed to lay the tramways, so that for a distance of thirty feet or upwards a less space than nine feet six inches, or if it is intended to run thereon carriages or trucks adapted for use upon railways, a less space than ten feet six inches shall intervene between the outside of the footpath on the side of the street or road and the nearest rail of the tramway; in the case of a bill for constructing a tramroad or tramway the notice shall specify the gauge to be adopted and the motive power to be employed.

* The first part of this article appeared in our issue of November 10.

Publication of Notices in Gazettes and Newspapers.

In the months of October and November, or either of them, immediately preceding the application for a bill, the notice must be published once in the London, Edinburgh, or Dublin *Gazette*, as the case may be, and in the following newspapers:

(1) In the case of a bill relating specially to any particular city, borough, town, or urban district, the notice must be published once in each of two successive weeks, with an interval between such publications of not less than six clear days, in some newspaper or newspapers published in such city, borough, town, or district, or if there be no newspaper published therein, then in some newspaper or newspapers published in the county in which such city, borough, town, or district, or any part thereof, is situate.

(2) In the case of a bill authorising the construction of works or the taking of lands, or extending the time granted by a former Act for the construction of works or taking of lands situate in one county only, or relating to an undertaking or to lands situate in one county only, or promoted by a company or companies or other parties possessed of an undertaking situate in one county only, the notice shall be published once in each of two successive weeks, with an interval between such publication of not less than six clear days, in some newspaper or newspapers published in that county, or if there be no newspaper published therein, in some newspaper or newspapers published in some county adjoining or near thereto.

(3) In the case of a bill authorising the construction of works, or the taking of lands, or extending the time granted by a former Act for the construction of works or the taking of lands in more than one county, the notice shall be published once in each of two successive weeks, with an interval between such publications of not less than six clear days, in some newspaper or newspapers of the county in which the principal office of the company or companies, or other parties, who are the promoters of the bill, is situate, and in some newspaper or newspapers published in each county in which any new works are proposed to be constructed, or in which any lands are intended to be taken, or in which any works or lands are situate, in respect of which any new or further powers for the completion or taking thereof are intended to be applied for, or if there be no newspaper published therein, then in some newspaper or newspapers published in some county adjoining or near thereto.

No publication under this Order shall be made after November 27.

Posting of Notices of Tramway Bills.

When the bill contains powers authorising any alteration or disturbance of the surface of any street or road, notice thereof must be posted for fourteen consecutive days in every such street or road in such manner as the authority having the control of such street or road shall direct, and if after such applications to such authority no such directions shall be given, then in some conspicuous place in every such street or road, and such notice shall also state the place or places at which the plans of such tramway will be deposited. These notices must be posted in the months of October or November, or one of them, immediately preceding the application for a bill.

Notices and Applications to Owners, Lessees, and Occupiers of Lands and Houses.

The Standing Orders of both Houses are with slight verbal alterations identical. Standing Order 11 declares that:

On or before the 15th day of December immediately preceding the application for a bill for power to take any lands or houses compulsorily, or for compulsory user of the same, or for an extension of the time granted by any former Act for that purpose, or to impose an improvement charge on any lands or houses, or to render any lands or houses liable to the imposition of an improvement charge, application in writing shall be made to the owners or reputed owners, lessees or reputed lessees, and occupiers of all such lands and houses, inquiring whether they assent, dissent, or are neuter in respect of such application; and in cases of bills included in the second class, such application shall be, as nearly as may be, in the form set forth in the appendix marked (A).

Appendix (A).

Sir.—We beg to inform you that application is intended to be made to Parliament in the ensuing session for "An Act" [here insert the Title of the Act], and that the property mentioned in the annexed schedule, Part I., or some part thereof, in which we understand you are interested as therein stated, will be liable to be taken compulsorily for the purposes of the said undertaking [and that the property mentioned in the annexed schedule, Part II., in which we understand you are interested as therein stated, will be liable to have an improvement charge imposed upon it].

We also beg to inform you that a plan and section of the said undertaking, with a book of reference thereto, have been or will be deposited with the [several Clerks of the Peace or principal Sheriff Clerks, as the case may be] of the counties of [specify the counties in which the property is situate], on or before the 30th November, and that copies of so much of the said plan and section as relates to the parish or other area in accordance with the terms of Standing Order 20, as the case may be, in which your property is situate, with a book of reference thereto, have been or will be deposited for public inspection with

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the [Clerk, or other officer in the said Order respectively mentioned, as the case may be], on or before the 30th day of November, on which plan your property is designated by the numbers in the annexed schedule.

As we are required to report to Parliament whether you assent to or dissent from the proposed undertaking, or whether your are neuter in respect thereto, you will oblige us by writing your answer of assent, dissent, or neutrality in the form left herewith, and returning the same to us with your signature on or before the day of next; and if there should be any error or misdescription in the annexed schedule, we shall feel obliged by your informing us thereof, at your earliest convenience, that we may correct the same without delay.

We also beg to inform you that it is intended that the Act shall provide to the effect that, notwithstanding section 92 of the Lands Clauses Consolidation Acts, 1845 [or section 90 of the Lands Clauses Consolidation (Scotland) Act, 1845], you may be required to sell and convey a part only of your property, numbered on the deposited plans.

We are, Sir,

Your most obedient servants,

Note.—If the application is forwarded by post, the words "Parliamentary Notice" are to be printed or written on the cover.

Schedule referred to in the foregoing notice describing the property therein alluded to:

	Parish or other area, as the case may be.	Number on Plans.	Description.	Owner.	Lessee.	Occupier.
		PART I.				
Property which may be taken compulsorily.						
		PART II.				
Property on which an improvement charge may be imposed.						

12. Separate Lists shall be made of the names of such owners, lessees and occupiers, distinguishing those who have assented, dissented or are neuter in respect to such application, or who have returned no answer thereto; and where no written acknowledgment has been returned to an application forwarded by post, or where such application has been returned as undelivered at any time before the making up of such list, the direction of the letter in which the same was so forwarded, shall be inserted therein.

13. On or before the fifteenth day of December immediately preceding the application for a bill for the laying down a tramway, notice in writing shall be given to the owners or reputed owners, lessees, or reputed lessees, and Occupiers of all houses, shops, or warehouses abutting upon any part of any street or road where, for a distance of thirty feet or upwards, it is proposed that a less space than nine feet six inches shall intervene between the outside of the footpath on either side of the road and the nearest rail of the tramway, or a less space than ten feet six inches, if it is intended to run on the tramway carriages or trucks adapted for use upon railways.

13A. On or before the fifteenth day of December immediately preceding the application for any bill for laying down a tramway crossing any railway or tramway on the level, or crossing any railway, tramway, or canal by means of a bridge, or otherwise affecting or interfering with such railway, tramway, or canal, notice in writing of such application shall be served upon the owner or reputed owner, and upon the lessee or reputed lessee of such railway, tramway, or canal, and such notice shall state the place or places at which the plans of the tramway to be authorised by such bill have been or will be deposited.

16. On or before the fifteenth day of December immediately preceding the application for a bill whereby the whole or any part of a work authorised by any former Act is intended to be relinquished, notice in writing of such bill shall be served upon the owners or reputed owners, lessees or reputed lessees, and occupiers of the lands in which any part of the said work intended to be thereby relinquished is situate.

17. On or before the twenty-first day of December immediately preceding the application for a bill, whereby any express statutory provision then in force for the protection of the owner, lessee, or occupier of any property, or for the protection or benefit of any public trustees or commissioners, corporation or person, specifically named in such provision, is sought to be altered or repealed, notice in writing of such bill, and of the intention to alter or repeal such provision, shall be served upon every such owner, lessee, or occupier, public trustees or commissioners, corporation or person.

19. All applications shall be made and notices served either by delivering the same personally to the party entitled to such application or notice, or by leaving the same at his usual place of abode, or in his absence from the United Kingdom with his agent, or by forwarding the same by post in a registered letter addressed with a sufficient direction to his usual place of abode, and posted on or before the third day previously to the day required for delivery of the same personally at such places, at such hours, and according to such regulations as the Postmaster General shall from time to time appoint for the posting aud regulations of such letters, and shall be accompanied by a copy of the Standing Orders which regulate the time and mode of presenting petitions in opposition to bills.

20. In all cases the written acknowledgment of the party applied to shall, in the absence of other proof, be sufficient evidence of such application having been made or notice given; and in case of an application or notice having been forwarded by registered letter, the production of the post office receipt for such letter shall be sufficient evidence of the due delivery of such letter provided it shall appear that the same was properly and sufficiently directed, and that the same was not returned by the post office as undelivered.

21. No notice served or application made on Sunday, Christmas Day, Good Friday, or Easter Monday, or before eight o'clock in the forenoon or after eight o'clock in the afternoon of any day, shall be deemed valid, except in the case of delivery of letters by post.

Standing Order 22, identical save in one important exception in both Houses, is one which gives the greatest trouble to promoters, dealing as it does with the consents of local authorities required in tramways bills. The additional words in the House of Lords Order are included.

In cases of bills to authorise the laying down of a tramway, the promoters shall, on or before the eighteenth day of January, obtain the consent of the local authority of the district or districts, through which it is proposed to construct such tramway, and where in any district there is a road authority, distinct from the local authority, the consent of such road authority shall also be necessary in any case where power is sought to break up any road subject to the jurisdiction of such road authority. For the purposes of this Order in England and Scotland the local and road authorities shall be the local and road authorities for the purposes of the Tramway Act, 1870, except that in the case of a rural district in England the rural district council shall be deemed to be the local authority, and in Ireland the local and road authorities shall be the district councils and the county councils respectively. Provided that where it is proposed to lay down a continuous line of tramway in two or more districts, and any local or road authority having any jurisdiction in any such district does not consent thereto, the consents of the local and road authorities having jurisdiction over two-thirds in length of the streets and roads along which such line of tramway is proposed to be laid shall be deemed sufficient.

Assuming that the Standing Orders have been complied with in respect of advertisements, and notices, and consents, the next matter most promoters have to consider is the question of the documents required to be deposited, and the times and places of deposit.

Documents Required to be Deposited, and the Times and Places of Deposit.

No deposit required by the following Orders shall be deemed valid if made on a Sunday, Christmas Day, Good Friday, or Easter Monday, or before Eight o'clock in the forenoon, or after Eight o'clock in the afternoon of any day.

Deposits on or Before the Thirtieth of November.

24. In cases of bills of the second class, *i.e.*, *inter alia* tramway bills, a plan and duplicate thereof, together with a book of reference thereto, shall be deposited for public inspection at the office of the Clerk of the Peace for every county, riding, or division in England or Ireland, or in the office of the principal Sheriff clerk of every county in Scotland, and where any county in Scotland is divided into districts or divisions, then also in the office of the principal Sheriff clerk in or for each district or division in or through which the work is proposed to be made, maintained, varied, extended, or enlarged, or in which such lands or houses are situate, on or before the Thirtieth day of November immediately preceding the application for the bill.

The House of Commons Standing Order has these additional words . . . . and the clerks of the peace or sheriff's clerks, or their respective deputies, shall make a memorial in writing upon the plans, sections, and books of reference so deposited with them, denoting the time at which the same were lodged in their respective offices, and shall at all seasonable hours of the day permit any person to view and examine one of the same, and to make copies or extracts therefrom; and one of the two plans and sections so deposited shall be sealed up and retained in the possession of the clerk of the peace or sheriff clerk until called for by order of one of the two Houses of Parliament.

On or before the thirtieth day of November a copy of the said plans, sections, and books of references . . . . shall be deposited in the Private Bill Office of this House (House of Commons).

25A. In cases of bills for laying down a tramway an ordnance map of the district, on a scale of not less than six inches to a mile, with the line of the proposed tramway marked thereon, and a diagram, on a scale of not less than two inches, with the line of the proposed tramway marked thereon, and a diagram, on a scale of not less than two

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inches to a mile, prepared in accordance with the specimen to be obtained at the office of the Board of Trade, shall also be deposited at that office on or before the thirtieth of November.

27. In the case of . . . tramway . . . bills a copy of all plans, sections, and books of reference required by Order 24 to be deposited in the office of any clerk of peace or sheriff's clerk on or before the thirtieth day of November immediately preceding the application for the bill . . . shall on or before the same day be deposited in the office of the Board of Trade.

28. When the works or any part thereof will be situate in London, or where powers are sought to take or use any lands compulsorily in London, a copy of so much of the plans, sections, and book of reference as relates to London shall, on or before the thirtieth day of November, be deposited at the office of the London County Council.

29. Where under the powers of any bill any work is intended to be made, maintained, varied, extended, or enlarged, or any lands or houses may be taken or used compulsorily, or an improvement charge may be imposed, a copy of so much of the said plans and sections as relates to any of the areas hereinafter mentioned, together with a copy of so much of the book of reference as relates to such area, shall, on or before the thirtieth day of November, be deposited with the officer respectively hereinafter mentioned, that is to say, in the case of -

(*a*) The city of London, or any borough in England or Wales, whether metropolitan or other, with the Town Clerk of such city or borough;

(*b*) Any urban district in England or Wales, not being a borough, with the Clerk of the District Council;

(*c*) Any parish in England or Wales having a Parish Council, with the Clerk of the Parish Council, or, if there is no clerk, with the Chairman of that Council;

(*d*) Any parish in England or Wales comprised in a rural district, and not having a Parish Council, with the Chairman of the parish meeting, and with the Clerk of the District Council;

(*e*) Any burgh in Scotland, with the Town Clerk or Clerk;

(*f*) Any parish in Scotland, outside a burgh, with the Clerk of the Parish Council;

(*g*) Any urban or rural district in Ireland, with the Clerk of the District Council.

30. Where by any bill power is sought to take any churchyard, burial ground, or cemetery, or any part thereof, or to disturb the bodies interred therein, or where power is sought to take any common or commonable land, as the case may be, a copy of so much of the plans, sections, and books of reference required by these Orders to be deposited in the Private Bill Office in respect of such bill as relates to such churchyard, burial ground, or cemetery, common or commonable land, shall, on or before the thirtieth day of November be deposited at the Office of the Secretary of State for the Home Department, and a copy of so much of the said plans, sections, and books of reference as relates to such common or commonable land shall, on or before the said day, be deposited at the Office of the Board of Agriculture.

31. Wherever any plans, sections, and books of reference, or parts thereof, are required to be deposited, a copy of the notice published in the *Gazette* of the intended application to Parliament shall be deposited therewith.

A petition for a tramway bill must be headed by a short title descriptive of the undertaking or bill and corresponding with that at the head of the advertisement, with a declaration signed by the agent, and a printed copy of the bill annexed shall be deposited in the private bill office on or before the seventeenth day of December. Such declaration shall state to which of the two classes of bills such bill in the judgment of the agent belongs. The declaration is to state the powers given by the bill in certain cases. The declaration shall also state that the bill does not give any powers other than those included in the notices of the bill.

By Order 33 a printed copy must be deposited on or before the eighteenth day of December, and in the case of London at the office of the County Council, copies of estimates, declaration, and lists of owners, lessees, and occupiers, which are required by the Standing Orders of the House, shall be deposited in the Private Bill Office on or before the thirty-first day of December, copies of estimates and declarations must be delivered at the Private Bill Office.

43. If it be intended to divert, widen, or narrow any public carriage road, navigable river, canal or railway, the course of such diversion, and the extent of such widening or narrowing, shall be marked upon the plan.

45. In cases of bills for laying down a tramway, the plans shall indicate whether it is proposed to lay such tramway along the centre of any street, aud if not along the centre, then on which side of, and at what distance from an imaginary line drawn along the centre of such street, and whether or not, and if so, at what point or points it is proposed to lay such tramway, so that for a distance of thirty feet or upwards a less space than nine feet six inches, or if it is intended to run thereon carriages or trucks adapted for use upon railways, a less space than ten feet six inches shall intervene between the outside of the footpath on either side of the road, and the nearest rail of the tramway.

All lengths shall be stated on the plan and sections in miles, furlongs, chains, and decimals of a chain. The distance in miles and furlongs from one of the termini of each tramway shall be marked on the plan and section. Each double portion of tramway, whether a passing place or otherwise, shall be indicated by a double line. The total length of the road upon which each tramway is to be laid shall be stated (*i.e.*, the length of route of each tramway).

The length of each double and single portion of such tramway, and the total length of such double and single portions respectively shall also be stated.

45A. In the case of bills containing power to impose on any lands or houses, or to render any lands or houses liable to the imposition of any charge in respect of any improvement, the plan shall define the improvement, and also the improvement area (being the limits within which the charge may be imposed).

Book of Reference.

46. The book of reference shall contain the names of the owners or reputed owners, lessees or reputed lessees, and occupiers of all lands and houses which may be taken or used compulsorily, or upon which any improvement charge is imposed or which are rendered liable to have an improvement charge imposed upon them, and shall describe such lands and houses respectively.

The amount of the deposit is generally ascertained by the Parliamentary agent. With reference to the plans, these must comply with the terms of the following order.

In the case of double lines (including passing-places), the distance between the centre lines of each line of tramway shall be marked on the plans. This distance must in all cases be sufficient to leave at least fifteen inches between the sides of the widest carriages and engines to be used on the tramways when passing one another. The gradients of the road on which each tramway is to be laid shall be marked on the section. Every crossing of a railway, tramway, river, or canal, shall be shown, specifying in the case of railways and tramways whether they are crossed over, under, or on the level.

All tidal waters shall be coloured blue.

All places where for a distance of thirty feet and upwards there will be a less space than nine feet six inches between the outside of the footpath on either side of the road and the nearest rail of the tramway shall be indicated by a thick dotted line on the plans on the side or sides of the line of tramway where such narrow places occur, as well as noted on the plans, and the width of the road at those places should also be marked on the plans.

The preceding paragraph shall apply, in the case of a tramroad, wherever it is carried along a street or road.

56. An estimate of the expense of the undertaking under each bill of the second class shall be made and signed by the person making the same.

57. In the case of a tramway bill authorising the construction of works by other than an existing tramway company, incorporated by Act of Parliament, possessed of a railway or tramway already opened for public traffic, and which has during the year last past paid dividends on its ordinary share capital, and which does not propose to raise under the bill a capital greater than its existing authorised capital, a sum not less than five per cent. on the amount of the estimate of expense, or in the case of substituted works, on the amount by which the expense thereof will exceed the expense of the works to be abandoned.

58. Where the work is to be made, wholly or in part, by means of funds, or out of money to be raised upon the credit of present surplus revenue, belonging to any society or company, or under the control of directors, trustees, or commissioners, as the case may be, of any existing public work, such parties being the promoters of the bill, a declaration stating those facts, and setting forth the nature of such control, and the nature and amount of such funds or surplus revenue, and showing the actual surplus of such funds or revenue, after deducting the funds required for purposes authorised by any Act or Acts of Parliament, and also the funds which may be required for any other work to be executed under any bill in the same session, and given under the common seal of the society or company, or under the hand of some authorised officer of such directors, trustees, or commissioners may be deposited, and in such case no deposit of money shall be required in respect of so much of the estimate of expense as shall be provided for by such surplus funds.

Orders 57 and 58 of the House of Lords Standing Orders are to the same effect.

135. The owner, lessee, or occupier of any house, shop, or warehouse in any street or road through which it is proposed to construct any tramway, and who alleges in any petition against a private bill or Provisional Order that the construction or use of the tramway proposed to be authorised thereby will injuriously affect him in the use or enjoyment of his premises, or in the conduct of his trade or business, shall be entitled to be heard on such allegations before any Select Committee to which such private bill is referred.

168c. In every bill for the construction of a tramroad of railway gauge, and intended to communicate with a railway, a clause shall be inserted that the provisions of the Railway and Canal Traffic Act, 1854, and of the Railway and Canal Traffic Acts, 1873 and 1888, shall apply to the company as if they were a railway or canal company, and

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to the tramroad to be authorised by the Act as if such tramroad were a railway or canal.

169. In every tramroad bill the length of so much of any tramroad as is to be constructed along any street or road, or upon any street or road, or upon any waste or open ground by the side of any street or road, shall be set forth in miles, furlongs, chains, and links or yards, or decimals of a chain, in the clause describing the works.

170. In every tramway bill the length of each tramway must be set forth in miles, furlongs, chains, and yards, or decimals of a chain, in the clause describing the works, with a statement in the case of each tramway, whether it is a single or a double line.

The following Orders have special relation to work which may be authorised to be carried out by local authorities:

170A. No powers shall be given to any local authority to construct, acquire, take on lease, or work any tramway, or portion of Tramway, beyond the limits of their district, unless such tramway or portion of tramway is in connection with the tramway belonging to or authorised to be constructed, acquired, or worked by the local authority, and unless the Committee on the bill shall determine that, having regard to the special local circumstances, such construction, acquisition, taking on lease, or working ought to be sanctioned.

In every case in which the Committee shall so determine, they shall specify what portion of the tramway will be situate beyond the district of the local authority to which the power of construction, acquisition, or taking on lease is given, and shall insert a clause for the protection of the local authority of the district in which such tramway or portion of tramway will be situate in the terms *mutatis mutandis*, of section 43 of the Tramways Act, 1870, except that the Committee may, if they think fit in the special circumstances of the case, substitute a period not exceeding forty-two years for the period of twenty-one years mentioned in that section.

171. Where a local authority are empowered to work any tramways belonging to, or authorized to be constructed or acquired by them, the Committee on the bill may, if they think fit under the special circumstances of the case, empower the local authority to enter into agreements for running powers over any tramways in connection with the tramways so worked or to be worked by them, and such running powers shall be deemed to be a purpose of the Public Health Act, 1875, and the expenses of the exercise of such powers shall, in the event of deficiency in the tramway account, be defrayed out of a local rate, as defined by the Tramways Act, 1870. Provided that in any such case the Committee on the bill shall make provision:

(1) That no such agreement shall have effect until approved by the Board of Trade;

(2) That all enactments, by-laws, and regulations relating to the use of or the running of carriages upon the tramways, and the taking of tolls and charges therefor, shall, so far as applicable, extend and apply, *mutatis mutandis*, to, and shall be observed by, the local authority exercising such running powers;

(3) That such running powers shall in no case be exclusive, and shall cease unconditionally at the expiration of seven years from the date of the agreement:

(4) That further agreements for the exercise of such running powers may be made from time to time with the approval of the Board of Trade for any period not exceeding seven years, providing that such powers shall cease unconditionally at the expiration of the period for which the same are given;

(5) That all questions in dispute as to the construction of or arising in consequence of such agreements shall be determined by arbitration.

And the Committee shall report the circumstances specially to the House.

The practice when the bill comes before Committee and counsel are engaged is not given here. This is a matter which the promoters may well leave in other hands. The bill follows the course of other bills, and requires the sanction of both Houses before it becomes law. In Committee, if opposed, it is necessary sometimes that a number of witnesses should be called; if unopposed, naturally few are needed to prove the preamble.

Metropolitan District Electrification.—A trial trip took place in the early hours of the morning on March 28, over the electrified District Railway between Mill Hill Park and Bow Road. General satisfaction with the results was expressed by the guests and railway officials present, among whom were Mr. John Young, general manager of the District Railway; Mr. Soar, traffic manager; Mr. King, engineer; Mr. Ellis, general manager of the Metropolitan Railway; Mr. Chapman, engineer-in-chief of the London Underground Railway Company; and Mr. A. P. Trotter, electrical adviser to the Board of Trade.

Top-covered Cars at Newcastle.—The two top-covered cars the Newcastle Corporation have been experimenting with have proved so successful that they have realised over 30s. a day more than the ordinary cars. The Tramways Committee have already agreed to cover twenty-two of the same type of cars, as they are being sent in for ordinary repairs and re-painting. It is expected an additional newly-constructed car will be brought on to the lines each fortnight, until this section of work is completed.

BOILER HOUSE ECONOMIES.*

By Reginald S. Downe, M.I.E.E.,
Borough Electrical Engineer, Southport.

The problem is to deliver a unit of electricity at the station bus-bars, with the minimum number of lbs. of coal, and this question is the most difficult one the engineer has to face in the power house, but the one most likely to give the best money return for the time expended on it. Coal in some cases accounts for 50 per cent. of the total costs. None of the items which make up the total costs of production, with the exception of coal, are capable of being materially reduced, as the economical limit has been reached; any further reduction can only be brought about by increased output.

A paper was read by a member, Mr. A. S. Giles, in January, 1904, before the Manchester section of the Institution of Electrical Engineers. From data supplied by the chief engineers of a large number of central stations, Mr. Giles compiled a table giving particulars of coal consumption, load factor, etc., which has been with his kind permission attached to this paper (Table A). The stations here tabulated represent fairly well the best practice now prevailing in this country, yet, the particulars given are so widely divergent that it is difficult to account for them. For instance, non-condensing stations with moderate load-factor and low-priced slack consume 6·5 lbs. per unit generated, whereas there are condensing stations with similar priced slack and higher load-factor consuming 10 lbs. and upwards. Broadly speaking, the only conclusion one can arrive at after carefully studying the table, is that the stations with the largest output and highest load-factor appear to give the best results, and that the other contradictory figures must be due to local or special conditions unknown to engineers. A central station is run on a money basis, and all the conditions are carefully studied when the lay-out of plant is decided upon; one can therefore only work in the most economical manner, and introduce such improvements and modifications as will give a reasonable return on the capital outlay. Each separate station has to be dealt with on its merits, and the measure of success is the net saving in the coal bill at the end of the year.

The great majority of stations burn bituminous slack, costing from 6s. to 12s. per ton delivered in the bunkers. Where the railway rate is high and smoke conditions stringent, Welsh coal is used; in a few cases where it is available, smudge, or low grade fuels are burned. This point is entirely settled by local conditions.

Assuming bituminous slack is used, how many pounds ought to be considered the maximum necessary to generate a unit of electricity? In a well-designed condensing station, with economisers and superheaters, and having a load-factor of not less than 15 per cent., in the author's opinion, with the experience at present available, it ought not to exceed 5 lbs. This quantity of coal should cover all the losses between the furnace and the engine. Several private industrial plants are now generating a unit of electricity with 3 lb. of cheap slack. No comparison however can be made between the coal consumption of private plants and public supply stations, the nature of supply being totally dissimilar. The results obtained are excellent, but under the same favourable conditions one could do better.

Before this problem can be dealt with, it is necessary to know where the losses are taking place. Are they due to low boiler efficiency, steam range losses, excessive steam consumption of engines, or all three? To enable this this to be ascertained it is necessary to have a rigid weekly analysis of units generated, together with coal and water used. In most works completed quite recently provision has been made for these measurements, and it is possible to have a daily analysis which enables a close check to be obtained, and any discrepancies to be immediately looked into. A number of stations of earlier date are not so well provided in this respect. It is, however, possible for all to obtain the weekly consumption of coal, and thereby calculate the pounds of coal per unit generated.

The measurement of water unfortunately is not such a simple matter; in many cases where the supply is not obtained from the town's mains it is not possible. Several stations have recently had water meters fixed; in some cases to each boiler, and in others to the main feed ranges. The author has tried several types of meters fitted on the suction and on the delivery sides of the feed-pumps, but found after a few weeks of constant running that water was passing without being recorded. It would be instructive to have the experience of those members who have water meters at work as to test their accuracy. In a large number of evaporation tests recently carried out by the author, meters have been discarded and two measuring tanks used instead. Where a duplicate feed range is available, tests of this character are quite simple. If it is not possible to isolate an economiser for the purpose of a test, hot water from the economiser delivery can be run into one tank, whilst the other is being emptied and pumped into the boiler, at 190° to 200° F.

* Paper read before the Incorporated Municipal Electrical Association at Derby, June, 1904.

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TABLE A.—COAL CONSUMPTION IN ELECTRICITY SUPPLY CENTRAL STATIONS.

Year 1902—1903.

Name of Town.	Quality and Calorific Value.	How Fired, Mechanical or Hand.	Steam or Electric Auxiliary Machinery Number of Units used.	Condensing or Non-condensing.	Percentage of Output Non-condensing.	Superheat in degrees Fahrenheit.	Price per Ton.	Lb. per Unit Generated.	Cost per Unit Generated.	Load Factor on Feeders
									d.	
Aberdeen	South Hetton, Wearmouth, Wilson and Clyde, etc....	hand and mechanical	both	both	13·4 N.C.	none	11/6—11/10 11,9—12/6	—	·47	17·49
Blackburn	Wigan slack 11,900	mechanical	both	both	—	none	7/3	10	·38	17·45
Blackpool	Lancs. slack and nuts	both	steam	N.C.	—	very little	10/- aver.	15·4	·826	14·32
Bootle	Lancs. slack	mechanical	both	condensing	—	none	7/6	9·02	·357	28·44
Bradford...	11,700 to 13,000 B.T.U.	mechanical	both	both	20·0 N.C.	partially	9/9 about	4·1	·214	20·93
Bristol	Rhymney washed peas 13,500 to 14,000 Hanham slack 12,500 to 13,000 ...	mechanical	mostly steam	condensing	—	partly 500°—560°	11/10—7/6	8·6	·54	13·75
Burnley	Small lump 13,290	both	electric	condensing	—	none	10/3	5·2	·28	15·59
Croydon	Best Welsh	hand	nearly all 372,140	condensing	—	partly up to 500	24/6	5·03	·66	16·81
Derby	Small peas 14,103...	both	both	condensing	—	50	7/8	13·2	·543	13·36
Devonport	Welsh	hand	steam	condensing	—	35	14/2	9·6	·72	19·02
Dundee	Fife small about 11,000	both	225,000 almost all	condensing	8% N.C.	very little	9/6—7/-	7·7	·35	13·63
East Ham	Hucknell steam and slack	hand	—	condensing	—	60° above	19/9—12/6	6·2	·6	12·95
Edinburgh	Washed nuts 12,500	almost entirely mechanical	both	non-condensing	—	slightly	6/11—7/6	6·35	·247	14·31
Glasgow	Washed nuts 11,000	mechanical	all purposes 745,801	condensing	—	500	7/-	6·05	·227	14·01
Halifax	Nuts and slack	mechanical	both 409,015	condensing	—	430 to 450	7/6	9·6	·39	16·98
Huddersfield	Slack	both	both	condensing	—	none	5/5	11·02	·296	10·47
Hull	Yorkshire steam 14,700	hand	steam	condensing	—	none	12/4	7·05	·465	9·96
Leeds	Smudge 10,000 11,000	mechanical	steam	condensing	—	portion to 460	5/-	8·4	·224	12·31
Nottingham	Partly large and partly pea nuts 9,000 10,000	both	steam chiefly	N.C.	—	none	9/- 9/6	6·5	·37	16·31
Salford	Slack	mechanical	elec. 554,381	condensing	—	50 to 100	8/4	4·3	·244	21·84
Sheffield	Engine slack 12,000	mechanical	—	condensing	—	none	7/9	7·8	·32	11·92
Southport	Slack	hand	both 95,377	condensing	—	60 to 100	8/6	6·5	·295	15·31
South Shields	Small	hand	steam	condensing	—	none	9/6	6·3	·32	15·82
St. Helens	Lancs. slack	hand	both	condensing	—	460	6/9	5	·18	19·78
Sunderland	Durham bean and small 13,480 ...	mechanical	both	both	40% N.C.	none	9/10	10	·535	17·87
West Ham	Best Welsh Derby pea nuts	both	steam	condensing	—	slightly	20/6 13/8	—	·75	12·82
		hand	both	—	10% N.C.	none	7/3 9/1	7·9	·43	18·38
South Country Station	Tredegar best Welsh 13,500	hand	both 180,177	both	—	none	22/4½	5·2	·637	17·38
Bolton	Engine slack	mechanical	both 427,351	both	16% N.C.	100	7/8	7	·281	18·87
Manchester	Washed slack 13,900	mechanical	both 1,368,794	both	22% N.C.	90° 30% of plant	9/11	5·22	·27	18·61
TRAMWAY GENERATING STATIONS.										
Glasgow	Washed singles 10,000	mechanical	elec. 988,000	condensing	—	390 400	6/8	3·64	·13	47·7
Sheffield	Treeton washed and screened nuts 13,700	principally hand	partly	condensing	—	none	8/8	4·3	·2	37·15
Hull	Hickleton Main washed slack... ...	mechanical	partly 93,861	condensing	—	none	12/4	8·9	·58	29·5

The various directions and means through which one may still hope to effect a further reduction in our coal consumption are included in the following list:

1. The influence of output and load-factor.
2. Bonus system for firemen.
3. Superheating.
4. Mechanical stoking and forced draught.
5. Fuel analysis.
6. Analysis of flue gases.
7. Auxiliary plant.
8. Feed-water purification and heating.
9. Prevention of radiation.

THE EFFECT OF OUTPUT AND LOAD-FACTOR.

The stations having the largest outputs and the highest load-factors show the best coal results. The coal bill of a station in its early stages, before the output has reached a reasonable figure, is often abnormal, owing to its being ready to supply before there is much demand. The conditions are not favourable to economical running, as the fuel required for banking, keeping steam on ranges, etc., is out of proportion to the output.

The effect of a bad load-factor is more pronounced in the boiler-house than in the engine-room. Diagram 1 attached shows Southport curves of load-factor, output, and pounds of coal per unit generated for the year 1903-4.

With graduated sizes of units it is possible to run the generating plant in a fairly economical manner. A standing engine does not waste coal. According to Stromeyer: "Under ordinary working conditions the radiation from a boiler amounts to from 5 to 10 per cent. If we work a boiler only at half of its power the amount of radiation will still be the same, for the steam temperature is not altered, but the ratio of loss by radiation to heat put into the boiler is doubled. On the other hand, if a boiler is overworked, resulting, of course, in inefficiency of the heating surface, the relative loss by radiation is very much reduced."

From this it appears conclusive that the number of boilers under steam should be kept to the minimum possible, and some method of assisted draught fitted to help us over the peak of the load.

The author thinks it will be admitted that with the class of slack usually burnt, under natural draught, the boiler duty is much lower than the maximum; in many cases the number of boilers under steam could be reduced 25 per cent. The station with which the author is connected has Lancashire boilers, and the coal required for lighting and banking fires has been found in the winter months to amount to between 5 and 7 per cent. of the coal consumed. There was a difference

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of 2 per cent. in economy between banking fires on the 8 ft. 6 in. boilers and allowing fires to die out on the 7 ft. boilers, and *vice versa*. A considerable amount of coal may be saved by finding out what banking conditions are most suited to the boilers at different periods of the year.

Bonus System for Firemen.

The personal factor in the form of the fireman has the greatest influence on the reduction of coal costs, after output and load-factor. In a test quoted by Mr. Bryan Donkin, four good stokers were put to fire the same boiler—a two-flued 30 ft. Lancashire under the same conditions. There was a difference between the most and least expert of 23 per cent. in capacity and 18 per cent. in economy, a saving of £7 to £8 per week, with coal at 10s. per ton.

All raw material from which there is no valuable bye-product passes through the hands of the fireman. As a rule he does his best, *i.e.*, with a fluctuating load he draws a fairly straight line on a recording steam pressure chart. He knows that the less coal he throws on, the less manual labour he is called upon to perform; he may also have a conscientious idea that by economising coal he is husbanding the national resources. Generally speaking, beyond that he has no incentive to economy, and provided he keeps a steady head of steam, is not interfered with. The man who actually burns the coal is the one who can effect the economies.

When the managing engineer has convinced himself that there are no leakages through the brickwork, when the dampers are easily accessible, draught gauges have been fitted to the chimney and each boiler, and CO_2 recorder has been fixed, he has done all that can possibly be foreseen, aud the rest must naturally be left to the leading firemen.

A pecuniary incentive is a great help towards reducing the coal bill. If a central station has not reached what it considers its minimum coal consumption, it is worth while paying at least 2s. to save 20s. worth of coal, which it could not otherwise do. It would be interesting to know what results have been obtained by this means. At Southport a coal bonus has been recently introduced, and the following particulars have been added, as they may be of interest to the members:

The present contract price of coal is 7s. per ton, delivered in the bunkers.

The approximate number of units generated per annum = 2,327,600.

The average number of units generated per week = 44,800.

A saving of one-tenth of a lb. of coal per unit generated on the averaged weekly output = £2 16s. 0d.

The bonus is divided amongst the four leading firemen, and is distributed monthly.

It has been fixed at 1s. per week per fireman for each tenth of a lb. of coal saved, *i.e.*, for every 56s. worth of coal saved 16s., or 28·5 per cent., is given as bonus.

The lbs. of coal below which a bonus is given has been fixed for the next financial year at 6·5 lbs. for the summer months and 5·5 for the winter months. If we have to pay more for our coal, the saving per ton is proportionately greater. Diagram 2 shows the bonus line at present fixed, and the lbs. of coal consumed for each month during the past three financial years, the load-factors being 14·22, 15·31, and 14·49 respectively.

Superheating.

No practical difficulties are experienced by using a moderate superheat up to 500° F. The saving in coal and steam may amount to between 10 and 20 per cent. and is greater where the engines are working under economical conditions, and where a steam ring is in use or the steam ranges are inordinately long. A superheater attached to a boiler may abstract 10 per cent. of the heat in the flue-gases, and reduce the efficiency of the boiler by this amount; as this 10 per cent. extra heat in the steam may reduce the engine losses by 20 per cent. the net gain is very great and alone would warrant adoption. The saving in steam is greater than the saving in coal, due to fuel being required to obtain the superheat.

Tables in text-books show the great saving to be obtained in coal and steam consumption by even a moderate superheat. Many stations are now working with superheaters in side-flues, which only increase the temperature some 50° F.; the gain in economy though great could be increased a further 5 per cent. by raising the superheat an additional 50° F. at the engine.

The author has superheaters fitted in the downtakes of all his Lancashire boilers, and has been able, by adding firebrick combustion chambers, to raise the temperature of the steam leaving the superheaters from 80° F. to 150°. Superheaters fitted in this way give a fairly constant degree of superheat, and require practically no attention. A consideration of the various types of superheaters is outside the scope of this paper, but the author is of opinion that where a high superheat of constant temperature is required (as in pure turbine stations), separately fired superheaters would be preferable.

The following figures were obtained at Southport on two eight-hour tests carried out on a 250 I.H.P. horizontal Musgrave-Corliss condensing engine, supplied with steam from a 7 ft. by 28 ft. hand-fired Lancashire boiler, with and without a Musgrave superheater:

		Without Superheater.	With Superheater.	Saving per cent. in favour of Superheater.
Water per I.H.P., per hour ...	lb.	16·30	13·58	17
Water per unit	lb.	29·27	24·24	
Coal per I.H.P. per hour ...	lb.	1·89	1·60	16
Coal per unit	lb.	3·40	2·86	
Average superheat at engine, 85° F.				

At the time of this test a ring steam range was in use, which has since been discarded; a similar test if taken to-day would not show quite the same saving.

Mechanical Stoking and Forced Draught.

To what extent does mechanical stoking influence the coal consumption in central stations? Makers' tests do not help much, as they are not carried out under every-day conditions. Table A does not show that stations mechanically fired are more economical than those hand fired. In a large power-house, having modern coal-handling plant, mechanical stokers undoubtedly save labour, and where the load-factor is high give economical results. In the class of station under consideration, viz., that having a total plant capacity not exceeding from 4,000 to 5,000 I.H.P., mechanical stokers are usually employed to enable bituminous coal to be burned with a minimum of smoke. Where the coal has to be thrown into the hoppers by hand there is no saving in labour, and it is doubtful whether any economy can be shown over hand-firing when the interest, repairs, and cost of running are taken into account, while on the other hand there may be obvious disadvantages.

The author does not wish to enter into a dissertation on the various types of coking or sprinkling, over-feed or under-feed stokers, but would be glad to elicit information from those engineers who have charge of hand and mechanically fired boilers, as to the economy or otherwise of the latter method of firing. As the furnace conditions are constant and uniform there should be a saving, but from figures supplied to the author from various stations employing mechanical stokers, it does not appear to him that this is attained in practice. Many types of stokers require steam for cooling the bars, and in one station where this was tested it amounted to as much as 11·5 per cent., but this was afterwards reduced to 3 per cent. At sea where the conditions do not lend themselves to mechanical stoking good results are unquestionably obtained by hand-firing.

With but few exceptions natural draught is depended upon for the combustion of fuel. Is it possible by adding induced or forced draught so to increase the evaporation and economy that after paying all charges there would be a saving that would be worth obtaining? A chimney is a rough-and-ready way of inducing the air to flow into the furnaces with sufficient velocity to cause the fuel to burn; it has the merit of being absolutely reliable and the upkeep is nil. Energy must be expended in bringing the air to the coal, but as a chimney may require 20 per cent. of the heat units in the coal, this work may be carried out much more efficiently by other means.

The apparent advantages of forced draught are: (1) The steaming power may be increased 30 to 40 per cent. without injury; (2) Higher temperature of combustion, giving a higher evaporative effect for the fuel; (3) Air supply under control.

Stromeyer in his Memorandum (1902) states: "Perfect combustion is of far more importance, both as regards the efficiency of a boiler and the power to be got out of it, than is within limits either the amount of heating surface or its arrangement."

The furnaces usually fitted by boilermakers are only suitable for burning anthracite coal or coke. As the majority of boilers burn bituminous coal, the efficiencies are extremely low, but could be raised if the furnaces were designed to suit the class of fuel burned. In a coal containing over 10 per cent. of volatile-hydrocarbon, a high temperature in the combustion chamber (approx. 1100° F.) is absolutely necessary for combustion. In most furnaces when the gases have distilled they immediately come in contact with water-cooled plates, and are reduced in temperature before combustion takes place. Until the temperature of combustion is raised sufficiently highly, the thermal efficiencies of boilers burning this class of fuel will remain in the neighbourhood of 50 per cent.

Fuel Analysis.

It is essential that the quality of the coal used should not be frequently changed, otherwise firemen cannot obtain the best results. How can one ascertain that the quality of coal contracted for is being delivered? Some engineers argue that by buying the cheapest slack obtainable in the district any deviation from the contract must be in their favour, but this method of procedure cannot always be recommended. Calorimeter tests of small quantities of coal, although fairly comparative, are not of much commercial value, because the thermal value of bituminous fuel is augmented by the hydrocarbons, a large proportion of which escape up the chimney without parting with their heat. The calorific value of some soft bituminous coal is equal to that of hard South Wales coals, but in practice the evaporation

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is much lower. If we obtain the percentage of moisture under similar weather conditions by drying a known weight of slack, and also ascertain the percentage of ash, it is possible to keep a reasonable check on the deliveries. In the author's opinion, evaporation tests made under similar conditions give the best practical results.

Where a contract is placed with a colliery, fewer deviations in quality are to be expected than where supplies are obtained from a coal merchant or colliery agent; where the colliery works only one seam of coal the conditions are even more favourable. Southport has placed a contract with the nearest colliery under the latter conditions, and the following two tests carried out by Mr. J. B. C. Kershaw, F.I.C., on samples delivered over six weeks show the qualities to be practically identical.

TESTS MADE ON SAMPLE AFTER DRYING.

Description of Sample.	Per cent. Moisture.	Per cent. Ash.	Per cent. Coke.	Per cent. Volatile Matter	Per cent. Fined Carbon.	Calorific Value in Fahrenheit Units.
Bickerstaffe slack "A" ...	8·48	11·00	68·60	31·40	57·60	13,879
" " "B" ...	7·73	10·85	67·35	32·65	56·50	13,848

ANALYSIS OF FLUE GASES.

For a complete analysis of the exit gases from a boiler it is necessary to know their chemical constituents, temperature, and draught. This information enables the engineer to reduce the loss up the chimney to a minimum; apparatus for carrying out these tests is now available. To obtain the greatest boiler efficiency the excess of air must be kept as low as possible, and this can only be ascertained by individual tests, and depends upon the quality of coal and the draught available. Every pound of air which passes through the boiler in excess of the theoretical quantity represents a dead loss, as this air has to be heated up from the temperature of the atmosphere to the temperature of the exit gases. To obtain perfect combustion of the fuel, as much oxygen as possible should combine with the carbon to produce carbonic acid. For practical purposes the amount of carbonic acid produced is an index to the state of combustion. Under theoretical conditions, without excess air, 19 per cent. CO_2 would be produced, but in everyday work one might with reasonable attention obtain 12 per cent. CO_2 with an exit temperature of 600° F. The difference between 8 per cent. and 12 per cent. CO_2 represents a loss of 8·5 per cent. of the fuel burned. Many works have recently fitted up recording apparatus to ascertain this percentage, and in most cases the results have been eminently satisfactory, and have well justified the outlay.

This arrangement for analysing the gases is more convenient than the "snap" method, and the readings are for all practical purposes correct, but can be checked by direct analysis. It is possible to connect the apparatus to each boiler in turn, and by reducing the air leakages, altering the thickness of fires, etc., to raise the average percentage of CO_2 considerably. Without some apparatus of this character it is not possible to keep a close watch on air leakages. Most boilers are surrounded by a quantity of brickwork which is notoriously porous, and as this brickwork is subjected to great changes of temperature the air leakage becomes excessive unless it is receiving constant attention. Air leakages being inwards are of an insidious character, and they do not show themselves but have to be searched for.

When boilers are shut down under natural draught there is always considerable air leakage into the main flue, even when the dampers are closed. Sliding dampers require to be an easy fit in their frames, but in most cases this is overdone; an improvement on the usual type of damper might be easily fitted. The brickwork round damper-frames is difficult to inspect; generally on being opened up it is found to pass cold air at every joint. This air has a considerable cooling effect on the gases; it decreases the draught and lowers the economiser efficiency. To what extent this cooling is possible is shown by the following figures, taken by the author from a range of six Lancashire boilers, No. 6 being nearest to the economisers:

Boilers Nos. 5 and 6 under steam.
Temperature of exit gases taken in side flues at a point 12 ins. on boiler side of dampers.

Average temperature of exit gases	729° F.
" " " gases in centre of main flue opposite No. 6 Boiler	314° F.
Average temperature of gases entering economisers	496° F.
" " " leaving economisers ..	291° F.

The stream of cold air leaking past the four standing boilers passing up the centre of the main flue, and mixing with the hot gases from Nos. 5 and 6 boilers, reduced their temperature 233° in 10 ft. of flue The fall in temperature through the economisers was only 205°. If it is not possible to prevent these air leakages at the dampers, on shutting a boiler down for any length of time, it is advisable to brick up the furnaces.

The author has had one form of CO_2 recording apparatus fitted in his boiler house for the past eight months, and has found it extremely useful. When first installed it was impossible to get more than from 2 to 3 per cent. CO_2 from certain boilers; on tests he has since obtained 15 to 16 per cent. as a maximum, but the average daily running works out about 10 per cent.

Two boilers, even after the brickwork had been thoroughly overhauled, would not give more than 3 per cent. CO_2. On further investigation being made it was found that there was an opening at the back dead-plates, just behind the bridges, measuring 30 in. by 3 in.; this was a drastic remedy of the boilermakers for smokeless combustion. On bricking up these openings the CO_2 was equal to that given by the other boilers, and they naturally gave a better duty.

AUXILIARY PLANT.

Mechanical stokers, economiser-scrapers, coal elevators, and ash conveyors are now generally electrically driven. Most stations, however, still have steam feed pumps which are notoriously inefficient, and may require from 2½ to 3½ per cent. of the steam generated. With a careful subdivision of electrically driven feed pumps this may be reduced to 1½ per cent. The first cost of the pumps is greater, but, after meeting all charges, there is a distinct saving, and they are as reliable as any other type of feed pump. It is, however, advisable to have a steam pump as stand-by in the event of any local or other failure of the supply.

FEED WATER PURIFICATION AND HEATING.

An exhaustive paper, entitled "An inquiry into the working of various water-softeners," by Mr. C. Stromeyer and Mr. W. C. Baron, was recently read before the Institution of Mechanical Engineers, dealing with the different impurities to be found in feed water and their effects on boilers, and the various types of softening and purifying apparatus at present to be found in the market. It is therein stated that:

> Scale does not materially reduce the efficiency of a boiler, but it seriously increases its wear and tear, whereby its life is considerably reduced; it also endangers the safety of boilers. The same remarks apply to coatings of grease due to feeding the boiler with water containing condensed steam from the engine. It is highly desirable to remove every trace of grease from the feed water. This cannot be done by filters, the only efficient method is to add mineral matter in solution to the condensed water, and then to cause precipitation by chemical means.

In every case where water is treated it should be done externally before entering the boiler. For economical steaming a boiler should be cleaned inside and out, because the transmission of heat is rendered easier and the evaporation is increased.

It is a generally accepted fact that no economy can be obtained by raising the temperature of feed water except by heat which would be otherwise wasted. Is it possible by having separately fired feed-heaters in series with economisers, to put the water into the boilers at the same temperature as the steam, and so obtain more duty per boiler, and reduce the number under steam, thus effecting a saving in coal? The true function of a boiler would then be steam raising, and not feed heating in addition. Under existing methods the limit to which heating can at present be carried is to have an exhaust heater in the path of the steam, on its way from the cylinder to the condenser, and in series with it a heater which will utilize the exhaust steam from the auxiliary engines, the water afterwards passing through a third heater in the form of an economiser. The temperature to which the feed water can be raised has a decided bearing on the subject, as the economy resulting from raising feed water from 150° to 250° F. is 10 per cent.

PREVENTION OF RADIATION.

When the boilers and piping have been covered with the most suitable material, it is necessary to have it periodically examined and repaired, as it is usually of a perishable nature. Where it is enclosed in a metallic envelope much waste may be caused if there is contact between the piping and the shield, which may be at nearly the temperature of the steam. Condensation may be reduced one-half if the valve-bodies and flanges are covered. The joint itself may be left exposed, but with superheated steam there is little trouble from leaky joints, if the ranges are well drained.

CONCLUSIONS.

Perfect combustion of fuel cannot be obtained in any form of boiler, but it ought to be possible to considerably raise the low thermal efficiencies at which most of them are working at the present time. The two essentials are: the highest possible initial temperature in the combustion process, as the heat transmission between the water and the hot gases is directly proportional to their difference of temperature; and a high temperature in the combustion chamber, so that the volatile gases are not cooled down before combustion takes place. To obtain full value from bituminous coal is a exceedingly difficult matter and the numerous papers which have dealt with this problem do not assist us much.

The subject is usually dismissed as follows: "In a properly constructed furnace these valuable hydrogen units can be utilised to their full value, but time does not permit of going further into this matter." What engineers are seeking is the properly constructed furnace, suitable for the particular class of slack to be burnt. The author has carried out a large number of evaporation tests at different rates of

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combustion, and with different forms of combustion chambers, on hand-fired 7 ft. by 28 ft. Lancashire boilers. The evaporation per lb. of coal from and at 212° F., varied at 6·62 lb. to 7·17 lb. Coal burnt per square foot from 33 lb. to 17 lb. Evaporation from 5,250 lb. of water per hour to 3,900 lb., and the superheat from 151° F. to 80° F. One boiler is fitted with steam blowers. On test 5,400 lb. of water per hour was evaporated. After deducting the steam taken by the blowers, the evaporation per lb. of coal was only 6·21 lb.

On a special test it was found that the steam jets when giving a draught equal to ⅜ in. in the ashpits required 340 lb. of steam per hour, equal to 6 per cent. of the steam generated. The fine ash made by the ordinary furnaces amounting to 3 per cent. of the coal burned, approximately 200 tons per annum, is dealt with by this boiler; it was found to have an evaporation value equal to one-half that of the slack.

Under the conditions stated, in Southport they obtained an average evaporation of 7 lb. of water per pound of coal, having a calorific value of 13,800 B.T.U. Their average combined boiler superheater efficiency therefore is only 52 per cent.

Electrical engineers have made great progress in this special branch of steam engineering, due in great measure to the fact that they are the largest purveyors of energy in a form which is readily and accurately measured. Before the advent of electricity supply these investigations were entirely in the hands of marine and water engineers, who were restricted to measuring their energy in indicated H.P.-hours, which is neither a convenient nor particularly accurate method. As this question is now being intelligently dealt with by electrical engineers all over the country, we may confidently look forward to great improvements in the immediate future.

LONDON COUNTY COUNCIL TRAMWAY MATTERS.

Plant and Tools for Repairs.

At a meeting of the London County Council on March 7, the Highways Committee presented a report, in which they stated that they had had under consideration the question of providing adequate accommodation for the repair and overhauling of the electric cars. Having regard to the great increase in the system, more complete arrangements should be made at an early date for repairs. The present system of executing repairs at the several car-sheds did not properly meet the needs for the undertaking. Special repair shops should be provided in some central position where the cars could be periodically overhauled, and where spare parts could be made. The Committee would report at a later date upon the proposal to erect new buildings specially for the purpose, but in the meantime it was of importance that more satisfactory provision than now existed should be made as an instalment of a larger scheme. They thought that a portion of the large car shed which was being erected at New Cross Gate should be temporarily equipped as a workshop. For this purpose it would be necessary to provide plant, tools, and machinery, at an estimated cost of £5,000. The Committee proposed, if their recommendation was approved, to obtain prices from selected firms for the supply of the materials. They recommended the approval of the estimate of £5,000, and that they should be authorised to take all necessary steps for obtaining and installing the plant referred to.

Thames Steamboat Service.

Though the matter cannot be described as connected with tramways, the proposal of the Rivers Committee submitted to the meeting in reference to the Council's steamboat service is of some interest in connection with improving the means of local communication in London. The Committee reported that they had carefully considered the question of the names which should be given to the Council's steamboats, and they submitted a list selected from names of distinguished persons more particularly connected with the Thames, beginning with King Alfred and coming down in time to Thomas Carlyle and William Morris. In regard to the fares to be charged, the Committee presented a table, which was framed on the following scale:

Not exceeding 3 miles,			1d.	single,	2d.	return.
From 3 to 5		,,	2d.	,,	3d.	,,
,, 5 to 8		,,	3d.	,,	5d.	,,
,, 8 to 11		,,	4d.	,,	6d.	,,
Over 11		,,	5d.	,,	8d.	,,

Tramway Estimates.

Mr. J. A. Baker, in reply to a number of questions on the report of the Highways Committee, said the rear lights had been partly discontinued in order to save current for running more cars. When the Greenwich generating station was completed there would be no cause for complaint in this respect. The present horse lines would scarcely bear the weight of a motor car—viz., seven tons. As to the cost of running an electric car, a return from forty-three municipal and company-owned electric tramway undertakings showed that the cost per car mile was about 6¾d. The Council's estimates for 1903-4 were based on a cost per car mile of 8·11d., but that was during reconstruction. The final accounts showed the cost was 7·92d. The estimates for 1904-5 were based on 8d. per car mile, but despite the fact that they had written off £22,120 in respect of the temporary generating station instead of £9,000 as expected, the working cost would come out at 7½d. per car mile, and if allowing 1d. per car mile extra cost for the temporary supply of current, the cost would be about 6½d. per car mile, or below the average of the forty-three companies and municipalities mentioned.

Municipal Inconsistency in Workmen's Tickets.

A long debate took place with regard to the workmen's tickets to be issued for the new steamboat service. The Rivers Committee recommended that the workmen's tickets should be issued to all persons desiring to travel by boats timed to arrive at the termini on week-days by 8 a.m. It was pointed out that the Council had opposed railway and tramway Bills for the purpose of obtaining a concession to workmen so that workmen's tickets should be issued up to 8 a.m. from the point of departure, and that to now fix the time proposed would be a glaring inconsistency. It was urged on behalf of the Committee's proposal that the steamboat service was merely experimental, and that the concession asked for meant a loss of several thousands a year. The Committee's recommendations, notwithstanding a strong Labour protest, was carried by a large majority.

A New Loan.

At the meeting of the Council, March 14, the Finance Committee submitted a report recommending that, in order to meet the further funds required for the capital account, the Council should issue further 3 per cent. stock to the value of £2,500,000. They also proposed that the issue should be made by tender and not at a fixed price as had been the case with the two last issues. The stock would not be redeemable until after March 19, 1920, but after that date it would be redeemable at the option of the Council at par, provided that one year's notice of any such intended redemption should have been previously given. The tenders would be opened at the Bank of England on March 21. Out of the total of £2,500,000 the sum required for tramway purposes is £207,700.

The Highways Committee.

The General Purposes Committee recommended the appointment of the various committees of the Council for the ensuing year, giving the names which they proposed; and the following was the list put forward to constitute the Highways Committee:

J. A. Baker (re-appointed *Chairman*).	J. W. Cleland.	I. H. Mitchell.
Sir R. M. Beachcroft.	Capt. F. Hemphill.	R. C. Phillimore.
J. W. Benn.	N. W. Hubbard.	D. S. Waterlow.
Sir H. W. Bliss.	W. C. Johnson.	T. Wiles.
E. Browne.	Sidney Low.	T. Mackinnon Wood.

Greenwich Generating Station.

The Highways Committee in their report stated that some additional expenditure would be required, besides the £2,000 already authorised, for the making of surveys, preparation of plans, etc., in connection with the second portion of Greenwich generating station. They proposed that an additional expenditure of £1,500 be approved for the purpose.

The Purchase of the South Eastern Tramways.

In a separate report, the Highways Committee adverted to the purchase by the Council of the Woolwich and South East London Tramway Company's undertaking, consisting of about 4¾ route miles of narrow gauge tramways, with depôt, cars, etc. At the arbitration proceedings to fix the price, the claim put in by the company was £57,206, together with £25,000 in respect of the cost of certain street widenings, which it was contended would have been insisted upon by the road authority as a condition of its consent if the undertaking had been promoted at the present time. This further claim had been contested, but no evidence was taken before the referee, Major Cardew, pending the decision of the High Court on the same point raised by the London, Deptford, and Greenwich Tramways Company. The High Court subsequently decided against the contention of the last-named company, and, thereupon, the street-widening claim in respect of the Woolwich Company was not further proceeded with. On February 16 the referee's award was announced, the same being £46,152 for the tramways, lands, buildings, works, materials, and plant, but not including harness, consumable stores, etc., which would be taken over at a valuation. The committee thought that the result was satisfactory on the whole. It was proposed that the undertaking should be transferred to the Council at midnight on March 31, and be worked by the Council from that date. In the meantime, the committee were considering the steps necessary with regard to the organisation of the permanent service, the engagement of staff, etc. In the first instance, however, it was suggested that the employees of the company should be taken temporarily into the Council's service at their present rates of pay and conditions of employment. The committee recommended that an estimate of £50,000 for the purchase of the undertaking should be approved, and that their other suggestions should also be confirmed. The Finance Committee, reporting upon the subject, pointed out that

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in a previous report, when the Council decided to acquire these tramways, they had stated that from a purely financial point of view, it was at least doubtful if the undertaking would pay its way, and that the purchase must, therefore, be justified upon the ground that it was required by the general policy of the Council.

The Highways Committee's reports were adopted with the exception of that dealing with the South Eastern Tramways, which was postponed, and the committee for the ensuing year was constituted as recommended.

WOOLWICH AND SOUTH EAST LONDON TRAMWAYS.

The postponed report of the Highways Committee which was brought up to the Council on March 14, with reference to the purchase of the Woolwich and South East London Tramways Company's undertaking, was considered at the meeting of the Council on March 21.

NEW CHAIRMEN OF COMMITTEES.

The Highways Committee reported that they had re-elected Mr. J. Allen Baker as chairman, and elected Captain F. Hemphill as vice-chairman for the ensuing year. They had appointed their chairman to represent them on the General Purposes Committee. The Finance Committee reported that they had re-elected Lord Welby as chairman.

RATES OF PAY IN ROLLING STOCK DEPARTMENT.

The rate of pay for fitters in the rolling stock repairs branch of the tramways department, designated as charge men, was fixed from £2 to £2 10s. a week.

The reports were adopted.

PROPOSED VISIT OF THE CHIEF OFFICER TO AMERICA.

The Highways Committee on March 28 submitted a recommendation to the Council that the chief officer of the tramways, Mr. A. L. C. Fell, should, during the Easter vacation visit New York, Boston, Washington, and certain other large cities in the Eastern States of America, and that a sum not exceeding £150 should be appropriated for his expenses. The Committee referred to the memorandum prepared by their chairman, Mr. J. Allen Baker (published in THE TRAMWAY AND RAILWAY WORLD of March 9, 1905), showing the results of the working of the electric conduit tramways of New York. As the chairman observed, the greater experience and length of time of working the conduit tramways in New York have resulted in considerable economy in working and improvement in many details of organisation, which indicate that the Council's conduit tramways may be still further improved. The Highways Committee think it would be of great advantage for the Council's chief officer to make a detailed examination of the system of organisation which exists in the electric tramways in certain important cities in the United States. They also desire to afford him facilities for inspecting the arrangements for working through traffic, with a view to ensuring the adoption on the Council's tramways of a type of tramcar that will enable advantage to be taken to the utmost of the carrying capacity of the cars used in connection with through services. They think it desirable that the officer should make a thorough examination of the system in New York of conduit cleaning, and of the method of organisation and control of the tramways stores depôts.

THE WOOLWICH AND SOUTH EAST LONDON TRAMWAYS.

As previously mentioned, it was proposed that this undertaking should be transferred to the Council at midnight on March 31, but as the result of further negotiations with the Company, the Highways Committee have now recommended that the transfer of the undertaking should be postponed until May 31.

ELECTRICAL EQUIPMENT OF THE SOUTH LONDON TRAMWAYS.

The Highways Committee, at the same meeting of the Council, presented a report recommending the adoption of the conduit system on the South London tramways and the proposed Garratt Lane line. Drawings and a description of the system of traction to be used, which will be submitted to the Board of Trade and to the local authorities, have been prepared, and the details of the system proposed are similar to those approved by the Board of Trade for certain tramways on the north of the Thames, and provide for a centre conduit slot one inch in width.

The length of the tramways affected is approximately 17½ miles of single line (South London lines 12¼ miles, and Garratt Lane lines 5¼ miles), and the total estimated cost of reconstruction and construction respectively, exclusive of sites for buildings, is estimated at £443,775, made up as follows:

	£
Track work—South London lines	205,000
,, ,, Garratt Lane lines	75,000
Cables and cable ducts	51,000
Cars	41,400
Buildings—Car sheds	42,000
,, Sub-stations	15,375
Plants, etc., for sub-stations	14,000
	£443,775

The tramways referred to are as follows: The tramways in Defoe Road, Garratt Lane, South Street, Red Lion Street, and York Road being part of tramway No. 12 authorised by the London County Council (Tramways and Improvements) Act, 1901, and for the reconstruction of so much of the tramways acquired from the late South London Tramways Company as are situated in North Street, York Road, Battersea Park Road, Nine Elms Lane, Wandsworth Road, Albert Embankment, Lambeth Palace Road, Stangate, Lambeth Road (between Lambeth Bridge and St. George's Circus), and Falcon Road (between Clapham Junction and York Road).

It is proposed to provide on the site of the existing car shed at Jew's Row, Wandsworth, a new car shed. The site will be enlarged by the acquisition of adjoining properties, and negotiations for this are now proceeding. The two sub-stations required for transforming the electrical power for working the tramways will be erected respectively on a portion of the site of the existing depôt at Queen's Road, Battersea, of which the Council has recently purchased the freehold, and on the site known as "The Gables," especially secured for the purpose at East Hill, Wandsworth. The above-mentioned approximate estimate of £57,375 includes the whole cost of these buildings which, when completed, will serve not only the tramways now under consideration, but also other tramways in the neighbourhood, when reconstructed for electrical traction; but, as regards the plant and equipment for the sub-stations, only such provision is made in the estimates as is required for the lines now proposed to be constructed or reconstructed.

The Highways Committee thought it desirable that as much as possible of the work, both of the track reconstruction and the erection of the buildings, should be pressed on at once, in order that economy may be secured from carrying out these operations during the summer months. It is anticipated that, if this course is adopted, the lines will be ready for electrical working before the summer of 1906, by which date it is probable that the first portion of the Greenwich generating station will be in use. The addition of the tramways in question to the power load of the station, it may be stated, will result in an appreciable economy in the working of the whole of the lines operated from the Greenwich station.

The Highways Committee, in recommending the adoption of the underground conduit system, estimate that the results of working, including in the capital charges a proper proportion of the cost of car sheds and sub-stations, will show an annual deficiency of £6,138, which it is expected will decrease by about £667 a year as the debt is paid off.

The Finance Committee, in reporting in the estimates, state that the electrical reconstruction of the lines would no doubt lead to increased traffic, but add that no figures could be given that could be relied upon. Provision has been made for the payment of interest and sinking fund charges amounting to £4,000 a year, and for the cost of street widenings amounting to £4,618 a year. Provision has also been made of £8,486 for renewals calculated at 1d. a car-mile estimated to be run. In considering the estimated financial results, the Finance Committee pointed out that the South London lines now worked by horse traction show at present a loss amounting to £3,500, before paying interest and sinking fund charges, in the year 1904-5. The Finance Committee, in conclusion, noted that although this reconstruction involved a large outlay of money it was not expected to result in any surplus after the net charges have been met, at any rate for some years to come.

The recommendation relating to the visit of the chief officer to America, which was opposed, stood over until the following week.

The report of the Highways Committee as regards the reconstruction of tramways in South London also stood over, as required by the standing orders.

In reply to Mr. GASKELL (Clapham),

Mr. J. ALLEN BAKER, chairman of the Highways Committee, said that he thought there would be no difficulty in distinguishing in the weekly returns the receipts from electric traction, and horse traction respectively, and also the mileage. He promised to look into the matter.

The Establishment Committee have approved the proposal of the Highways Committee to employ three additional assistants temporarily in the engineer's department, up to and including March 31, 1906, at a rate of pay not exceeding £5 a week each.

The Works Committee have re-elected Mr. A. M. Torrance as chairman, and have elected Mr. Edward Smith as vice-chairman for the ensuing year.

CHELTENHAM AND DISTRICT LIGHT RAILWAY.—Major J. W. Pringle, the Board of Trade inspector, visited Cheltenham on March 28 and inspected the recent tramway extensions. The route mileage of the extensions is about four and a half miles, and the track mileage exceeds six miles. The inspector was accompanied by several members of the Corporation and officials. Mr. H. J. McCormick (general manager of the Company), Mr. E. Dodd, of Birmingham (the engineer of the line), and others. The inspection passed off satisfactorily, and though the Board of Trade's formal authorisation of the new lines has to be awaited, it was understood the inspector unofficially expressed the view that there was no objection to an immediate opening of the lines for traffic.

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ANALYSES OF TRAMWAY REPORTS.

LEEDS CORPORATION TRAMWAYS.

YEAR ENDING MARCH 25, 1904.

Electric traction inaugurated, August, 1897.

	£	s.	d.
Borrowing powers	1,156,483	18	6
Loans outstanding	1,019,311	0	1
Sinking Fund	109,706	5	10
Depreciation and reserve	82,906	1	8

CAPITAL EXPENDITURE.

	£	s.	d.
Permanent way	486,606	18	10
Electrical equipment of line	170,533	7	4
Land, buildings, and fixtures	121,957	3	4
Power-station and sub-station plant	115,649	18	1
Workshop tools and sundry plant	18,401	12	4
Cars	157,361	14	2
Other rolling stock	15,167	8	3
Miscellaneous equipment	2,886	15	5
Office furniture	758	18	0
Parliamentary expenses	69	8	8
Preliminary expenses	8,100	4	11
Proportion of costs of issue of 3 per cent. stock	10,483	18	6
Total	£1,107,977	7	10

Capital expenditure per mile of single track, £13,595.

REVENUE ACCOUNT.

INCOME.

	£	s.	d.	Av. per Car Mile d.
Traffic revenue	277,665	12	1	10·72
Other revenue	2,897	4	2	·11
	£280,562	16	3	10·83

EXPENDITURE.

Power Expenses.

	£	s.	d.		d.
Generating electricity	11,401	13	5		·44

Traffic Expenses

	£	s.	d.			d.
Superintendence	2,407	13	3			·09
Wages (motormen and conductors)	58,639	12	3			2·26
Wages (other traffic employees)	3,564	5	11			·14
Cleaning and oiling cars	6,984	15	2			·27
Cleaning track	663	2	8			·03
Fuel, power, light, and water for depôts	1,565	11	3			·06
Ticket check	2,911	18	9			·11
Uniforms	1,781	7	10			·07
Miscellaneous	1,078	7	10			·04
				79,596	14 11	3·07

General Expenses.

	£	s.	d.			d.
Salaries	2,462	4	8			·10
Sundry wages	344	18	4			·01
Rents	1,194	4	2			·05
Rates	6,415	7	7			·25
Printing, stationery, and advertising	1,570	17	2			·06
Accident insurances and compensations	875	4	7			·03
Fire and other insurances	321	9	0			·01
Miscellaneous	1,655	6	2			·06
				14,839	11 8	·57

Repairs.

	£	s.	d.			d.
Permanent way	22,043	3	5			·85
Electric equipment of line	2,547	7	9			·10
Buildings	886	3	3			·03
Cars	16,265	2	7			·63
Power-station plant	883	5	1			·03
Miscellaneous	431	16	0			·02
				43,056	18 1	1·66
Total				148,894	18 1	5·75
Balance carried to Net Revenue Account				131,667	18 2	5·08
				£280,562	16 3	10·83

NET REVENUE ACCOUNT.

	£	s.	d	£	s.	d
Balance from Revenue Account				131,667	18	2
Deduct—						
Interest	27,291	14	3			
Sinking Fund	27,441	3	2			
Income tax	5,921	2	11			
Depreciation	19,013	17	10			
				79,667	18	2
Balance, transferred to relief of rates				£52,000	0	0

TRAFFIC STATISTICS.

Population served	437,000
Length of line operated (single)	81½ miles
Passengers carried	60,739,234
Car mileage	6,215,799
Passengers carried per car mile	9·77
Average fare per passenger	1·10d.
Operating expenses per passenger	·59d.
Percentage of operating expenses to total receipts	53·07
Board of trade units (traction)	8,519,868
Cost of Board of Trade unit	·29d.
Board of Trade units per car mile	1·40

CARDIFF CORPORATION TRAMWAYS.

YEAR ENDING MARCH 31, 1904.

Electric traction inaugurated, May, 1902.

	£	s.	d.
Loans outstanding	473,129	9	6
Sinking Fund	20,429	10	10

CAPITAL EXPENDITURE.

	£	s.	d.
Permanent way	194,562	16	10
Electrical equipment of line	91,695	19	3
Lands and buildings	110,567	12	11
Power-station plant	87,424	1	1
Cars and other rolling stock	67,629	5	6
General	8,487	13	9
Expenses raising stock	28,463	0	4
Purchase of old undertaking	98,391	11	5
Total	£687,222	1	5

Capital expenditure per mile of single track, £24,654.

REVENUE ACCOUNT.

INCOME.

	£	s.	d.	Av. per Car Mile d.
Traffic receipts	101,794	6	3	9·241
Advertising	14	10	7	·001
Electric energy sold to Lighting Dept.	6,224	14	3	·565
	£108,033	11	1	9·807

EXPENDITURE.

Power Expenses.

	£	s.	d.	£	s.	d.	d.	d.
Salaries and wages	3,444	9	10				·313	
Fuel	5,881	12	9				·535	
Water	469	16	6				·042	
Oil, waste, and stores	739	13	6				·068	
Miscellaneous	40	17	1				·004	
				10,576	9	8		·962

Traffic Expenses.

	£	s.	d.	£	s.	d.	d.	d.
Superintendence	180	0	0				·016	
Wages of motormen and conductors	25,565	2	11				2·321	
Wages of other traffic employees	5,716	19	9				·520	
Uniforms	498	14	8				·045	
Tickets, punches, & boxes	680	5	3				·063	
Licences	133	12	6				·012	
Gas and water	74	9	1				·006	
Miscellaneous	267	9	10				·023	
				33,116	14	0		3·006

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General Expenses.

	£ s. d.	£ s. d.	d.
Salaries and wages	2,268 18 3		·206
Rents	511 17 1		·046
Rates and taxes	3,119 7 8		·284
Fire insurance	399 6 7		·036
Printing and stationery	452 9 9		·040
Fuel, light, and water for offices	136 15 10		·013
Auditor's fee	50 0 0		·004
Accident insurance	2,544 17 2		·231
Miscellaneous	191 0 1		·016
		9,674 12 5	·876

Repairs.

	£ s. d.	£ s. d.	d.
Permanent way	2,115 10 11		·192
Electrical equipment of line	1,248 7 0		·114
Power-station and sundry plant	866 11 7		·079
Rolling stock	10,470 17 7		·950
		14,701 7 1	1·335
Total		68,069 3 2	6·179
Balance carried to Net Revenue Account		39,964 7 11	3·628
		£108,033 11 1	9·807

NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account		39,964 7 11
Deduct—		
Interest	19,219 12 10	
Sinking Fund	14,083 17 5	
Composition duty and management of stock	297 19 2	
		33,601 9 5
Balance, being surplus on year's working		**£6,362 18 6**

Of this sum £642 has been applied to relief of rates, £403 0s. 4d. has been taken for construction of a terminus loop, and £5,317 18s. 2d. has still to be allocated by Committee.

TRAFFIC STATISTICS.

Population served	164,315
Length of line operated (single)	27mls. 70chs.
Passengers carried	23,574,204
Car mileage	2,643,762
Passengers carried per car mile	8·917
Average fare per passenger	1·036d.
Operating expenses per passenger	·693d.
Percentage of operating expenses to total receipts	63

KINGSTON-UPON-HULL CORPORATION TRAMWAYS.

YEAR ENDING MARCH 31, 1904.

Electric traction inaugurated, July, 1899.

	£ s. d.
Borrowing powers	445,000 0 0
Loans outstanding	308,027 13 2
Sinking Fund	35,359 18 8
Reserve Fund	44,058 1 11

CAPITAL EXPENDITURE.

	£ s. d.
Permanent way	164,731 14 10
Electrical equipment	39,137 12 1
Ground	15,984 18 3
Buildings	29,032 3 6
Power-station plant	30,613 13 7
Miscellaneous plant	378 6 11
Rolling stock	67,062 8 10
Parliamentary expenses	1,422 3 9
Depôts and track: horse system	12,500 0 0
Old permanent way renewals	8,080 17 7
Drypool and Marfleet undertaking	15,033 8 0
Total	£383,977 7 4

Capital expenditure per mile of single track, £14,117.

REVENUE ACCOUNT.

INCOME.

	£ s. d.	Av. per Car Mile d.
Traffic revenue	100,642 5 1	9·61
Other revenue	201 16 9	·02
	£100,844 1 10	9·63

EXPENDITURE.

Power Expenses.

	£ s. d.	d.	d.
Generation of electricity	6,644 4 6		·63

Traffic Expenses.

	£ s. d.	£ s. d.	d.
Salaries	783 6 8		·08
Wages	18,521 4 4		1·77
Cleaning and oiling cars	3,695 5 0		·35
Uniforms	1,051 8 10		·10
Ticket check	198 8 9		·02
Miscellaneous	108 18 2		·01
		24,358 11 9	2·33

General Expenses.

	£ s. d.	£ s. d.	d.
Salaries	739 1 4		·07
Rents, rates, and taxes	8,164 3 8		·78
Licences	79 10 0		·01
Printing, stationery, and advertising	506 7 9		·05
Insurance and compensation	273 16 11		·02
Miscellaneous	455 19 7		·04
		10,218 19 3	·97

Repairs.

	£ s. d.	£ s. d.	d.
Permanent way	1,529 12 7		·15
Electrical equipment	2,226 19 4		·21
Buildings	896 8 8		·09
Rolling stock	13,075 18 3		1·25
Machinery	2,445 16 2		·23
		20,174 15 0	1·93
Total		61,396 10 6	5·86
Balance carried to Net Revenue Account		39,447 11 4	3·77
		£100,844 1 10	9·63

NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account		39,447 11 4
Deduct—		
Interest and Sinking Fund	19,079 10 11	
Income and property tax	1,382 17 3	
Reserve Fund	7,485 3 2	
		27,947 11 4
Balance carried forward		**£11,500 0 0**

TRAFFIC STATISTICS.

Population served	248,000
Length of line operated (single)	27 mls. 16 chs.
Passengers carried	24,220,718
Car mileage	2,512,821
Passengers carried per car mile	9·64
Average fare per passenger	1·00d.
Operating expenses per passenger	·60d.
Percentage of operating expenses to total receipts	60·88
Board of Trade units (traction)	3,158,376
Works cost per Board of Trade unit	·64d.
Board of Trade units per car mile	1·26

NEWCASTLE CORPORATION TRAMWAYS.

YEAR ENDED MARCH 25, 1904.

Electric traction inaugurated, December, 1901.

	£ s. d.
Loans outstanding	991,259 16 10
Sinking Fund	55,983 9 0

CAPITAL EXPENDITURE.

	£ s. d.
Purchase of tramways, etc.	33,944 9 9
Permanent way	367,552 3 8
Electrical equipment of line	63,416 3 2
Land, etc.	55,375 16 11
Buildings and fixtures	173,462 15 4
Power-station plant, etc.	75,589 9 2
Workshop tools and sundry plant	6,216 14 3
Cars	133,306 9 6
Other rolling stock	1,762 3 10
Furniture and fittings, etc	4,169 12 6
Extensions	137,906 16 2
Public power supply	1,790 1 5
Total	£1,054,492 15 8

Capital expenditure per mile of single track, £23,433.

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REVENUE ACCOUNT.

INCOME.

	£ s. d.	Av. per Car Mile d.
Traffic revenue	180,630 12 2	10·68
Other revenue	3,539 4 1	·21
	£184,169 16 3	10·89

EXPENDITURE.

Power Expenses.

	£ s. d.	d.	d.
Generating electricity	9,751 3 5		·58

Traffic Expenses.

	£ s. d.		
Superintendence	1,498 1 5	·09	
Wages (motormen and conductors	39,197 3 6	2·32	
Wages (other traffic employees)	6,183 16 11	·37	
Cleaning and oiling cars	8,315 16 3	·49	
Cleaning, salting, and sanding track	2,203 4 4	·13	
Fuel, power, light, and water for depôts	929 2 2	·05	
Ticket check	4,480 12 6	·27	
Uniforms	1,803 3 5	·10	
Miscellaneous	725 16 8	·04	
	65,336 17 2		3·87

General Expenses.

Salaries	2,243 19 8	·13	
Wages	581 9 3	·03	
Stores expenses	37 11 6	·002	
Rents	993 14 11	·06	
Rates and taxes	6,604 16 6	·40	
Printing and stationery	1,168 0 6	·06	
Advertising	143 13 1	·008	
Law charges	254 1 10	·02	
Accident insurance and compensation	3,105 10 8	·18	
Fire and other insurances	954 4 10	·06	
Miscellaneous	1,035 13 10	·06	
	17,122 16 7		1·01

Repairs.

Permanent way	11,134 10 4	·66	
Overhead work	1,463 19 3	·09	
Buildings	2,008 1 3	·12	
Power, pumping, and sub-stations, and on cables	1,912 17 0	·11	
Cars	11,257 16 4	·66	
Other rolling stock	296 4 1	·018	
Horsing expenses	290 18 8	·017	
Miscellaneous	124 14 2	·007	
	28,489 1 1		1·682
Total	120,699 18 3		7·14
Balance carried to Net Revenue Account	63,469 18 0		3·75
	£184,169 16 3		10·89

NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account		63,469 18 0
Deduct –		
Interest	28,896 0 4	
Sinking Fund	22,638 3 8	
		51,534 4 0
Repaid to City Fund to account of interest and Sinking Fund incurred during construction		£11,935 14 0

TRAFFIC STATISTICS.

Population served	257,000
Length of line operated (single)	45 miles
Passengers carried	39,715,120
Car mileage	4,059,907
Passengers carried per car mile	9·78
Average fare per passenger	1·09d.
Operating expenses per passenger	·73d.
Percentage of operating expenses to total receipts	65·54
Board of Trade units	7,757,885
Works cost per Board of Trade unit	·39d.
Board of Trade units per car mile	1·91

LONDON COUNTY COUNCIL TRAMWAYS.

YEAR ENDING MARCH 31, 1904.

Electric traction inaugurated, May 15, 1903.

	£
Loans outstanding	1,983,514
Sinking Fund	140,715
Depreciation, renewal, and reserve	30,772

CAPITAL EXPENDITURE.

	£ s. d.
Permanent way	621,347 12 2
Electrical equipment of line	104,427 9 2
Land and buildings (includes temporary car shed)	123,566 1 2
Power station (temporary) and sub-stations plant	37,951 4 2
Rolling stock	164,144 3 0
Workshop tools and sundry plant	608 2 7
Preliminary expenses	204 5 10
Miscellaneous	17,569 4 3
Horse and cable traction	1,075,616 16 7
Total	£2,145,434 18 11

Capital expenditure per mile of single track, £26,902.

REVENUE ACCOUNT.

INCOME.

	£ s. d.	Av. per Car Mile d.
Traffic receipts	516,487 3 0	10·744
Advertising	6,888 1 6	·143
Manure	669 15 10	·014
Rent	1,861 5 5	·039
Miscellaneous	165 2 4	·003
	£526,071 8 1	10·94

EXPENDITURE.

Power, Cable, and Horsing Expenses.

	£ s. d.	£ s. d.	d.	d.
Power	38,617 11 4		·803	
Cable	8,441 0 10		·175	
Horsing	105,560 15 5		2·196	
		152,619 7 7		3·17

Traffic Expenses.

Wages of drivers, motormen, and conductors	127,865 0 9		2·660	
Poleturners, pointsmen, and signalmen	5,680 12 10		·118	
Night inspectors	2,935 15 9		·061	
Regulators	6,249 2 7		·129	
Ticket inspectors, cashiers clerks, and vanman	8,541 13 6		·176	
Cleaning, lighting, and oiling cars	11,410 7 11		·237	
Cleaning, salting, and sanding track	5,740 7 7		·119	
Tickets and punch repairs	1,596 18 11		·033	
Licences	1,333 15 0		·027	
Gas and water	1,083 7 5		·023	
Uniforms	3,455 11 11		·072	
Miscellaneous	1,059 16 8		·022	
		176,952 10 10		3·68

General Expenses.

Salaries	7,962 10 7		·165	
Rents, rates, taxes, gas, and water	26,896 15 0		·568	
Insurance	948 17 4		·019	
Printing and stationery	752 4 9		·015	
Law charges	126 10 2		·002	
Workmen's compensation	121 16 6		·002	
Fee to solicitor's department	500 0 0		·010	
Compensation	7,959 6 6		·164	
Office and general	1,944 16 4		·040	
		47,212 17 2		·98

Repairs.

Permanent way	9,273 0 7		·193	
Buildings	2,071 16 6		·043	
Rolling stock	15,151 18 10		·315	
Feeder cables, machinery, and plant	3,844 0 9		·090	
Horses	14,537 2 6		·302	
Harness	1,018 15 7		·022	
Cable plant	5,931 4 0		·123	
Office furniture and advertising plant	110 0 9		·001	
		51,937 19 6		1·080
Total		428,722 15 1		8·910
Balance carried to Net Revenue Account		97,348 13 0		2·023
		£526,071 8 1		10·944

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NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account ..		97,348 13 0
Deduct—		
Interest	57,011 15 5	
Sinking Fund	43,524 19 4	
Liquidation of expenditure on Temporary Generating Station Account	2,895 12 5	
Income tax	2,200 0 0	
		105,632 7 2
Deficit on year's working		**£8,283 14 2**

TRAFFIC STATISTICS.

Length of line operated (single)	79 ms. 60 ch.
Passengers carried	133,139,085
Car mileage	11,536,534
Passengers carried per car mile	11·54
Average fare per passenger	·93d.
Operating expenses per passenger	·77d.
Percentage of operating expenses to total receipts ..	81·49

WIGAN CORPORATION TRAMWAYS.

YEAR ENDING MARCH 31, 1904.

Electric traction inaugurated, April, 1902.

	£
Borrowing powers	297,219
Loans outstanding	177,319
Sinking Fund	20,830

CAPITAL EXPENDITURE.

	£ s. d.
Purchase of Wigan & District Tramways undertaking	45,465 15 0
Land and buildings	12,876 6 1
Cars	18,263 18 3
Permanent way	48,704 19 9
Electrical equipment of line	19,586 13 9
Parliamentary expenses..	4,400 0 0
Miscellaneous	1,238 6 10
Steam traction expenditure	54,878 16 5
Total	**£205,414 16 1**

Capital expenditure per mile of single track, £16,270.

REVENUE ACCOUNT.

INCOME.

	£ s. d	Av. per Car Mile d.
Traffic revenue..	36,124 13 3	14·28
Advertising	490 7 3	·19
Sundries	93 4 8	·04
	£36,708 5 2	**14·51**

EXPENDITURE.

Power Expenses.

	£ s. d.	£ s. d.	d.	d.
Electric traction power cost	3,261 3 9		1·29	
Steam traction power cost	1,924 3 0		·76	
		5,185 6 9		2·05

Traffic Expenses.

Wages of motormen and conductors	2,599 8 2		1·03	
Wages of inspectors ..	383 1 8		·15	
Cleaning and oiling cars	459 15 3		·18	
Sand and carting ..	71 17 7		·03	
Uniforms	294 16 4		·12	
Licences	31 5 0		·01	
Miscellaneous	7 8 6		·003	
		3,847 12 6		1·52

General Expenses.

Salaries and wages ..	744 1 0		·29	
Rents, rates, and taxes ..	2,074 9 10		·83	
Printing, stationery, and tickets	245 19 10		·10	
Electric energy, gas, and water	51 9 2		·02	
Law charges	57 0 6		·02	
Insurance & compensation	436 7 1		·17	
Miscellaneous	146 12 2		·06	
		3,755 19 7		1·49

Repairs.

Permanent way	1,092 2 2		·43	
Electrical equipment of line	377 4 11		·15	
Cars	1,775 5 1		·70	
Buildings	188 12 1		·07	
		3,443 4 3		1·35
Total		**16,222 3 1**		**6·41**
Steam traction wages (traffic)		6,351 19 1		2·51
		22,574 2 1		8·92
Balance carried to Net Revenue Account		14,134 3 1		5·59
		£36,708 5 2		14·51

NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account ..		14,134 3 1
Deduct—		
Interest (net)	5,190 0 4	
Sinking Fund	5,348 7 0	
		10,538 7 4
Balance carried forward		**£3,595 15 9**

TRAFFIC STATISTICS.

Population served	60,000
Length of track operated (single)	12 mls. 50chs.
Passengers carried	6,300,432
Car mileage	607,058
Passengers carried per car mile	10·38
Average fare per passenger	1·37d.
Operating expenses per passenger	·86d.
Percentage of operating expenses to total receipts ..	61·50

LIGHT RAILWAY COMMISSION.

The Board of Trade have confirmed the Mid-Suffolk Light Railway (Halesworth Deviation) Order, 1905, amending the Mid-Suffolk Light Railway Order, 1900.

The Light Railway Commissioners have decided to hold a local inquiry respecting the Portmadoc, Beddgelert, and South Snowdon Railway (Light Railway) Order (application of November, 1904) at Carnarvon, on April 15.

The Commissioners sat at Warrington on Tuesday, March 14, to consider the application for an Order to authorise the proposed Knutsford and Warrington Light Railway. Owing to the opposition disclosed during the course of the inquiry, the application was withdrawn by the promoters.

On Wednesday, March 15, the Commissioners sat at Tarporley and granted the application for an Order to authorise the proposed Tarporley and Mouldsworth Light Railway.

The Commissioners sat at Maidstone on Friday, March 17, to hear the application for the proposed Headcorn and Maidstone Light Railway. The inquiry was adjourned till April 10, at the offices of the Commissioners.

The Commissioners sat at Barton-on-Humber, on March 21, to hear the application for the proposed Ackworth and Lindsay Light Railway. The Commissioners rejected the application on the ground that it should be submitted to Parliament.

The Commissioners issued their draft Orders on Tuesday, March 21, to authorise respectively the Newark and District Light Railways and the Maidstone Corporation Light Railways (extensions).

On March 27, the Light Railway Commissioners submitted to the Board of Trade for confirmation the Devonport Light Railway Order, authorising the construction of a light railway in the County Borough of Devonport.

On March 29, the Commissioners sat at Bideford to hear the application for an Order to authorise the Bideford, Clovelly, and Hartland Light Railway. There was no opposition, and the Commissioners granted the Order.

The Board of Trade have confirmed the following Orders:

Basingstoke and Alton Light Railway (Speed Amendment) Order, 1905, amending the Basingstoke and Alton Light Railway Order, 1897, as to speed.

Portsmouth and Hayling Light Railway Order, 1905, authorising the construction of a light railway in the borough of Portsmouth, and in the rural district of Havant in the county of Southampton, including a conveyor bridge over the Langstone Channel.

LORD CLAUD HAMILTON has been elected chairman of the East London Railway Company, in succession to the Hon. A. E. Gathorne-Hardy, who recently retired owing to his appointment as Commissioner under the Railway and Canal Traffic Act.

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ANNOTATED LAW CASES.

In the High Court of Justice.

King's Bench Division.

Before Mr. Justice Warrington, Sitting as an Additional Judge of the King's Bench Division.

T. Tilling, Limited, v. Dick, Kerr, and Company, Limited.

An important judgment was delivered on Saturday, February 18, by Mr. Justice Warrington, raising a question of metropolitan interest, and a further question of general interest. The facts of the case, which had been argued earlier in the week, were as follows: The plaintiffs, a a limited company, who carried on business as omnibus proprietors, brought an action against the defendants, Dick, Kerr, and Company, a limited company who had been carrying on the work of laying temporary tram rails over certain streets in Peckham, New Cross, and Greenwich. The statement of claim alleged that the defendants were employed by the London County Council to reconstruct and electrify certain tramways already existing in the south of London, in accordance with the powers and provisions of the London County Council Tramways Act, 1900, the London County Council Tramways and Improvement Act, 1901, and the Tramways Act of 1870. It was further alleged that in the course of their operations the defendants had unlawfully obstructed certain thoroughfares by laying and maintaining upon that part of the road which was open for vehicular traffic tram lines in such a manner that the uppermost surface of such rails was not on a level with the surface of the road as required by the Tramways Act, but projected above it to the extent of the full depth of the rail, thereby constituting a public nuisance. By reason of these obstructions the plaintiffs alleged that their omnibuses had been constantly injured. In their particulars the plaintiffs gave 60 specific instances of injury; they further complained of damage by reason of the extra strain which was put upon their horses and omnibuses by being obliged to cross and recross these raised rails, whereby the expense of maintenance had been increased, and the depreciation of their frames, axles, and wheels, had been accelerated. The question of liability was the one that was left for the Court to determine. By agreement, the question of damage was to be submitted to the Official Referee. Alternatively, the plaintiffs alleged that the defendants had negligently carried out their work, on the ground *inter alia* that they had provided a set of temporary raised rails for carrying on a double line of tramway traffic while one side of the roadway was up for electrification, instead of being satisfied to use only "crossovers" to turn the tram traffic on to the existing tram lines.

In the defence the defendants pleaded that they had acted in pursuance of statutory powers, and in respect of all but two of the specific instances of injury they relied upon Section 1 of the Public Authorities Protection Act. As the words of the section are material for the purpose of following the judgment of Mr. Justice Warrington, they are here set out: "Where after the commencement of this act any action, prosecution or other proceeding is commenced in the United Kingdom against any person for any act done in pursuance, or execution, or intended execution of any Act of Parliament, or of any public duty or authority, or in respect of any alleged neglect or default in the execution of any such act, duty, or authority, or in respect of any such act, duty, or authority, the following provision shall have effect: (*a*) The action, prosecution, or proceeding shall not lie or be instituted unless it is commenced within six months next after the act, neglect, or default complained of." The London County Council under their Act were empowered for the purpose of working the tramway by electrical power, to reconstruct or make such alterations of the tramways and to execute all such works on or in connection therewith in, over, or under the streets or roads in which the same were laid as were necessary for adopting the same to be so worked. It will be seen from this statement of the facts that the case was one of the utmost importance both to persons using the highways and to contractors under Local Authorities purporting to act in pursuance of the Tramways Act, and other special Acts of Parliament.

The judgment of Mr. Justice Warrington is not set out *in extenso*, but sufficiently for readers to grasp the salient points and the reasoning on which judgment was given for the plaintiffs. Dealing with the defence, he said: "The defendants rely (1) on the fact that the obstructions were placed in the road under statutory authority, (2) on the fact that as to the major portion of the acts complained of they were protected by the Public Authorities Protection Act. Alternatively, the plaintiffs allege that if the acts complained of were done pursuant to statutory authority there were done negligently, that is that the defendants abused their statutory authority." (Since Mr. Justice Warrington did not find as a judge of fact that there had been an abuse of the statutory authority, it is unnecessary to deal with this point, though contractors should note that where this state of things is proved, different considerations from these discussed in the present case will arise.)

The defendants, as contractors to the London County Council, signed a contract and specification. The specification provided *inter alia* that the price should include the provision and maintenance of all temporary lines, turn-outs, and cross-over roads to be used during reconstruction, so as to interfere as little as possible with the tramway traffic. By another clause the duty of observing the provisions of the statute were thrown upon the contractors. For example, to show how the defendants had proceeded, the defendants opposite the Royal Naval College at Greenwich had laid between the kerb on one side of the road and the permanent tramway a temporary line of rails, closing the other half of the road. The half of the road open was occupied by the permanent and the temporary line. The temporary line was constructed of rails with a bevel on either side from the ground to the height of about 2 inches, with a groove in the top to take the flange of the wheel. The uppermost surface was therefore above the level of the street. At intervals there were clamps and nuts projecting above the surface of the raised rails. At the two ends of each section so dealt with called a "turn-out," a junction was made between the temporary line and the permanent tramway. His Lordship continued, "I find as a fact that the raised rails were an obstruction to the highway and caused damage to the plaintiffs' omnibuses. There is evidence which I accept that it would have occasioned great inconvenience to the public if the service of cars had been interrupted, and that less real inconvenience was occasioned to traffic by the construction of turn-outs such as I have referred to than by carrying on the traffic by means of cross-overs at intervals." His Lordship then proceeded to enquire as to whether the section already referred to authorised the defendants to act as they had done, since without the authority of the statute the acts in question would have given rise to a cause of action. His Lordship came to the conclusion that the works constructed were not necessary for the purpose of adapting the tramways to be worked by electricity, but were necessary for the purpose of maintaining the tramcar service uninterruptedly. This being the case the defendants were not protected by the Act. The next question, and one of general importance, was whether the defendants were protected by the Public Authorities Protection Act. In Grenwell v. Howell, 1900, 1 Q.B. 535, it was held that the protection of the Act covered the officers of a public body and persons acting under their direct mandate, but no case decided that it extended to protect independent contractors doing, under a contract and for their own profit, the works which the public body is authorised to do. "In the absence of authority," His Lordship said, "I should have been prepared to hold that contractors undertaking work for their own profit are not protected." His Lordship went on to say that this view found support in a case of the Kent County Council v. The Corporation of Folkestone in the Court of Appeal where Lord Justice Romer said "In the first place it is to me clear that the Public Authorities Protection Act, 1893, has no application to this case. It was admitted, and rightly admitted, on behalf of the respondents that they could not say that this was an action, prosecution, or proceeding in respect of any alleged neglect or default in an Act of Parliament, or of a public body or authority, but it was contended that it was an action, prosecution, or proceeding, against a person, which includes a Corporation, for an act done in pursuance or execution, or intended execution, of an Act of Parliament or of a public duty or authority. When the facts of this case are considered it is clear that this action does not fall within these words, since the contractors did the damage to the road, and these were not the servants or agents of the authority in doing the damage; they being persons who contracted to deliver certain stores and material within the defendants' borough, and the way they should do it was for them to consider."

His Lordship (Mr. Justice Warrington) went on to comment on the words used by Lord Justice Stirling, and considering that the authority of the Court of Appeal was in point, he came to the conclusion that the defence of the protection of the Public Authorities Act was not available for the defendants, Dick, Kerr and Company, Limited. He therefore gave judgment for the plaintiffs, making a declaration that they were entitled to recover damages in respect of the matters complained of in the action, and to refer it to the Official Referee to ascertain the amount of the damages. He also awarded the costs up to judgment, leaving the subsequent costs to be dealt with by the Official Referee. A stay of execution, pending an appeal, was granted. The effect of this case is to deprive contractors of the benefit that they believed they had when carrying out contracts for local authorities, and in view of the decision of the Court of Appeal, cited by Mr. Justice Warrington, it is unlikely to be reversed without the defendants taking the case to the House of Lords.

The Birmingham and Midland Tramways Company is preparing for augmentation of its motor omnibus service on the Edgbaston and Harborne routes. Horsed vehicles will be entirely replaced by the petrol-driven conveyances, five of which are expected to be put on the road almost immediately. The new 'buses will be of light construction. The company has a large scheme on hand, their idea being to supersede the whole of the horsed vehicles by motor 'buses on the important routes.

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CORPORATIONS AND RAILWAY OMNIBUSES.

Representatives of Manchester Corporation Tramways and several other municipalities and of the North Eastern, Midland, and Great Western Railway Companies met in London on March 15, to consider the clauses of the three Companies' bills in the present session under which they seek power to run motor omnibuses. The Corporations, being dissatisfied with the clauses, caused the bills to be blocked on second reading, and the object of the conference was to secure a compromise. Councillor D. Boyle, chairman of the Manchester Tramways Committee, presided. Various suggestions were made by the municipal representatives to the railway companies' representatives, and a further conference was fixed. The municipalities recognise that they cannot plead the danger of competition against the proposals of the companies, for Parliament would hardly consent to give to a corporation the monopoly of its own streets for the services of public transport. The objection has, however, been put on the better ground that a corporation ought to retain the right of controlling the amount of vehicular traffic permitted on particular routes, and that it should, therefore, retain the power of granting licences which it at present possesses. The refusal of a corporation to grant a licence is, of course, subject to review by the court, and in case a railway company considered that a refusal to license its omnibuses was based on improper grounds it could appeal.

In the House of Commons on March 21, the North Eastern Railway Bill, having being read a second time,

Mr. Whitely moved that it should be an instruction to the Committee on the Bill to limit the provisions of clause 28 (dealing with the provision and running of motor omnibuses by the company) to omnibuses, coaches, etc., conveying persons, luggage, parcels, and goods to and from the company's railway stations.

Sir Edward Grey said that it appeared the object of this motion was to protect authorised tramways from undue competition. The point was one which could be dealt with at the Committee stage of the Bill, and he thought the company would then be prepared to say that the clause would not authorise them to run omnibuses in any borough or urban district, except to and from passenger stations of the company. In the rural districts, however, many facilities that could be given by the company would be of great benefit, and from that point of view the company could not accept the instruction.

Mr. Whiteley said he was satisfied and he withdrew his motion.

ACCIDENTS ON ELECTRIC RAILWAYS.

In the House of Commons, on March 7,

Mr. Herbert Samuel asked the President of the Board of Trade if he would state how many fatal and non-fatal accidents had occurred up to the present time through persons coming into contact with the live rail on electric railways, and whether the Board of Trade were taking any steps for the prevention of such accidents.

Mr. Gerald Balfour, in reply, said: On the Lancashire and Yorkshire and North Eastern railways nine fatal and twenty-two non-fatal accidents have occurred through contact with the electrically charged rail, including eight fatal and eight non-fatal accidents to trespassers, and one fatal and eleven non-fatal accidents to railway servants. No accidents from contact with the rail in question have been reported to the Board of Trade on any of the other lines which have recently been equipped for the use of electrical power in place of steam, and no such fatal accident has, it is believed, occurred on any of the tube railways. The number of known fatal accidents of this description on tube railways, some of which have been opened now for a considerable period, cannot be given, as no separate record of such accidents has been kept, but the number, if any, must be very small. Recommendations as to the steps to be taken to prevent the recurrence of accidents of this character have been made from time to time to the railway companies, and have been adopted by them, and the matter is one that receives unremitting consideration from the inspecting officers of the department in the execution of their duties.

In the House of Commons, on March 14,

Mr. Weir asked the Secretary to the Board of Trade, having regard to the fact that the North Eastern Railway Company had electrified a portion of their system without obtaining specific statutory powers, would he state whether he proposed to notify other railway companies in the United Kingdom of the irregularity of such a course; would he state how many miles of the North Eastern system had been electrified, on what date the system came into force, the number of accidents resulting therefrom, and the number of persons besides Alice Maughan who had lost their lives through contact with unprotected rails; whether compensation had been granted in the case of each accident; and whether the Board of Trade inspectors were now quite satisfied that the rails were sufficiently protected.

Mr. Bonar Law, in reply, said: The Board of Trade are not prepared to say that the North Eastern has been guilty of any irregularity, and see no necessity, therefore, to call the attention of the companies generally to the course adopted by that railway. I understood that the length of the company's line which has been electrically equipped is 33 miles, and that electrical working was begun towards the end of last March. Up to the present time, twenty-eight accidents have occurred from the use of electrical power on this railway; this number includes four fatal accidents, in addition to that mentioned by the hon. member, resulting from contact with the electrically charged rail. The Board of Trade are not aware whether compensation has been paid by the railway company in each case. An inquiry has been held into the accident to Alice Maughan, but the Board of Trade have not yet received the inspecting officer's report. The railway company has carried out the recommendations of the inspecting officers in so far as they have been made at present.

LONDON UNITED TRAMWAY CONTRACTS.

The London United Tramways Company have awarded to J. G. White and Company, Limited, the contracts for the construction and equipment of the stations of the London United system in the counties of Surrey and Middlesex. The work will be divided into two separate sections. The first—which comprises the boroughs and districts of Kingston, Surbiton, Malden, and Wimbledon—includes the following routes: Starting from the junction of London Road and Eden Street, the first route goes along Richmond Road as far as King's Road, and along King's Road to a terminus at the Kingston Gate of Richmond Park. The second route runs along London Road and Kingston Hill, terminating at George Road. The third route starts from a junction with the last mentioned and London Road, and goes along Cambridge Road, Kingston Road, Burlington Road, West Barnes Lane, and Coombe Lane, terminating near Raynes Park Station. The fourth route starts at Clarence Street, and goes along Eden Street, St. James's Road, Penrhyn Road (Kingston), Surbiton Crescent, Victoria Road, and Portsmouth Road, terminating at Winter's Bridge, Long Ditton. The fifth route begins with a junction with the fourth in Victoria Road, Surbiton, proceeds along that road and Ewell Road, terminating at Red Lion Lane, Tolworth. The total route length of this line is about 10¼ miles, and the length of single track is about 18¾ miles. The second section of the contract comprises lines in Hanwell and Brentford, starting from a junction with the existing tramways in High Street, Brentford, and proceeding along Boston Road and Lower Boston Road, and adjoining the existing tramway in High Street, Hanwell. Another branch goes along Boston Road, and joins the same tramway in Broadway, Hanwell. The route length of these lines is about 2⅞ miles, and the length of single track 5⅛ miles. The type of construction of the track is to be particularly strong, and will consist generally of No. 3 British Standard rails, with cross girders spaced 9 ft. apart throughout. The joints will be supported by anchors of H section, secured to the rails with bolts and clips. The concrete underbed will be 6 in. thick, finished off with a layer of 1 in. of fine concrete, and over this a floating coat of 1 in. of cement and sand to form the bed for the wood paving. The paving throughout will be of Jarrah wood, finished so far as regards the Kingston section with an edging of granite setts, but the Hanwell and Brentford section margins will be entirely of granite setts. Span wire overhead construction will be used throughout. The poles will be 23 ft. long, and the ornamental character of these will be similar to that used on the existing lines of the London United Company. The trolley wire will be 2/0 B. and S. gauge grooved copper wire, and will be supported by mechanical ears. The height of the wire above rail level will be 23 ft., which is somewhat greater than usual, but is required by the special conditions. The total amount of the contract with Messrs. J. G. White and Company is about £165,000.

The contract for the cable work has been placed with Messrs. W. T. Henley's Telegraph Works Company. This contract, which is one of the largest ever placed for cables in connection with tramway work, includes about 30 miles of three-phase 11,000 volt cable, and about 45 miles of low-tension feeder, distributor, and telephone cables, etc.

Buenos Ayres and Belgrano Electric Tramways Company.—The report for the year 1904 states that the following charges have been made to net revenue account: For debenture stock interest, £25,385; for renewals fund (thereby raising same to £21,000), £5,000; for amount written off capital expenditure, £4,500; to the credit of sinking fund for the redemption of debenture capital, £2,500; to the credit of accidents insurance fund (thereby raising same to £1,000), £500. After providing for these and for the premium on £2,300 5 per cent. debenture stock purchased and cancelled, there remains a balance of £42,336. The 6 per cent. dividend on the A and B preference shares absorbs £20,250. An interim dividend of 1½ per cent. on the ordinary shares was paid in October last, and the directors now recommend a balance dividend of 2s. 6d. per share, free of income-tax, or a total of 4s. per share, or 4 per cent. per annum, absorbing £20,000, and leaving a balance of £2,086 to be carried forward to next account.

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PERSONAL.

Mr. George Myerscough, of Sheffield, has been appointed depôt foreman of the Exeter Corporation Tramways.

Mr. Alfred Baldwin, M.P., has been elected chairman of the Great Western Railway Company, in succession to Earl Cawdor.

Mr. T. Tyson, chief assistant engineer to Leicester Corporation, has been granted an increase of salary from £160 to £200 per annum.

Mr. T. Medcalf has been appointed traffic manager of Swindon Corporation Tramways at a salary of £150 per annum.

Mr. F. J. C. May has resigned the position of borough surveyor and engineer for Brighton.

Mr. W. H. Brown, of 7, Lothbury, London, E.C., has been elected a director of the London United Tramways, Limited.

Mr. Thomas Hewson, borough engineer of Leeds, has resigned his position, after twenty-three years' service, on account of failing health.

Mr. Wm. Dundas, of Callender's Cable and Construction Company, has been appointed mains superintendent at Carlisle Corporation Electricity Works.

Mr. W. B. Worthington, engineer of the Lancashire and Yorkshire Railway, has been appointed chief engineer of the Midland Railway.

Mr. John Wilson, interim manager of Leith horse tramways, has been appointed by the Tramways Committee manager of the electric tramway system now being installed.

Mr. Edward Cross, the Rotherham borough electrical engineer, has also been appointed manager to Rotherham Corporation Tramways at a combined salary of £350 per annum.

Mr. Hancock, principal clerk in the traffic department of Manchester Corporation Tramways, has been appointed parcels superintendent, at a salary of £250.

Mr. W. A. Chamen, chief electrical engineer to Glasgow Corporation, has resigned his position in order to take up an appointment with Messrs. Bramwell and Harris.

Mr. Richard Evans, general manager for sixteen years of the Barry Railway Company, will shortly retire on a pension. He will be asked to accept a seat on the directorate.

Mr. J. Eades, Junr., car works manager of Manchester Corporation Tramways, has been appointed rolling stock superintendent, at £350 a year. His present salary is £250.

Mr. J. M. M'Elroy, general manager of the Manchester Corporation Tramways, delivered an illustrated lecture on March 16, in the new Islington Hall, Ancoats, on the Manchester tramway system.

Mr. T. R. Smith, electrical engineer of Leicester Corporation Tramways, has been granted an increase of salary from £250 to £300 per annum.

Mr. George New has been elected vice-chairman of the Sunderland Corporation Tramways Committee in place of the late Councillor Bryers.

Mr. W. J. Hosgood, chief engineer and locomotive superintendent of the Port Talbot Railway and Docks, South Wales, has been appointed chief mechanical engineer of the Rhodesian Railways.

Mr. F. Coutts, manager of the Ayr Corporation Tramways, who has been appointed manager at Paisley, has been presented by the employees with a green onyx drawing-room clock as a token of their esteem.

Mr. John Lambert, electrical engineer of Perth Corporation, has been appointed tramway manager. He will retain his former post, and his salary is to be increased from £275 to £350 per annum.

Mr. David C. Rattray, assistant engineer of the Lancashire and Yorkshire Railway, has been appointed chief engineer in succession to Mr. W. B. Worthington, who is about to take up the position of engineer-in-chief to the Midland Railway.

Mr. W. Grant, manager of the Rotherham Corporation Tramways, who is leaving in order to take over the management of the Ayr Corporation Tramways, was presented on March 18 by the officials and staff of the Rotherham Tramways Department with a silver tea and coffee set. Mr. Grant was the first manager at Rotherham and organised the tramway system.

Mr. J. R. Groves, late general manager of the Southtown and Gorleston Tramways, which were recently acquired by Great Yarmouth Corporation, has declined an offer made to him to continue his services under the Corporation after the conversion of the system to electric traction. We understand that Mr. Groves will shortly take up an appointment elsewhere under the British Electric Traction Company.

Mr. H. E. Blain, manager of West Ham Corporation Tramways, has been granted an increase of salary by £50, with a further increase next August of £50, and a third increase in February next of a further £50.

Mr. J. W. Benn, M.P. (chairman of the London County Council, and lately chairman of the Highways Committee), has been appointed a Deputy-Lieutenant, on the recommendation of the Duke of Fife (Lord-Lieutenant of the County of London).

Brighton Tramways Committee have decided to defer the appointment of a tramway manager, in succession to Mr. T. B. Holliday, for three months from April 30. In the meanwhile the managerial duties will be performed by Mr. Marsh, the present assistant-manager.

Mr. Hilliard Stephens, of 39, Victoria Street, London, S.W., has severed his connection with Mackenzie Brothers, and has been appointed sole London agent (engineering section) to the Falkirk Iron Company, Falkirk, N.B. All communications to be addressed to 39, Victoria Street.

Mr. Charles King, the permanent way engineer of the Glasgow Corporation Tramways, has resigned his position, having accepted a similar appointment under his old chief, Mr. John Young, general manager of the Metropolitan District Railway. Mr. King will take up his new duties at the end of the present month.

The Hon. A. E. Gathorne Hardy has been appointed Railway Commissioner in place of Viscount Govan, who has resigned. A salary of £3,000 per annum attaches to the post. Mr. Gathorne-Hardy, who is deputy-chairman of the South Eastern Railway Company, will also act as chairman of the Light Railways Commission.

Salford Corporation Tramways Committee have decided unanimously to recommend the Council to appoint Mr. George W. Holford general manager of the Corporation tramways in succession to Mr. Ernest Hatton, who is leaving for Newcastle. Mr. Holford has for some time been Mr. Hatton's chief assistant in the Tramways Department. The Committee recommend that his commencing salary as manager be £300 per annum, increasing annually by £50 to £500

Mr. M. A. Bell, who is at present accountant of Glasgow Corporation Tramways Department, recently received an appointment as chief accountant in Lisbon under Mr. William Clark, formerly permanent way engineer of Glasgow Corporation Tramways, who left Glasgow a few years ago, and has since been the very successful manager of the Lisbon Tramways. Mr. Bell, who is 25 years of age, accepts his new appointment at Lisbon at a salary of £400 per annum.

The Exeter City Council recently appointed a committee to consider certain charges which had been made in regard to the competency of the city electrical engineer, Mr. H. D. Munro. The committee, in their report, which is now issued, states that after careful inquiry they "are fully satisfied with the competency of Mr Munro as an electrical engineer, and are of opinion that the electrical engineer should have charge of all the works in connection with the electric light undertaking, including mains, and of the electrical equipment in connection with the tramways."

Southampton Borough Council have at length decided to appoint a general manager for the Corporation tramways. The salary is to be £500 per annum, rising, subject to approved services, by annual increments of £25 to £600. Some 60 applications were received. The final selection will be made from the following candidates: Mr. C. R. Everson, general manager, Plymouth Corporation Tramways; Mr. R. C. Bullough, general manager and engineer, Colchester Corporation Tramways; Mr. H. E. Yerbury, chief electrical engineer and deputy manager, Sheffield Corporation Tramways.

Mr. John Morris, the well-known solicitor, and principal of the firm of Ashhurst, Morris, Crisp and Company, of Throgmorton Avenue, died at the age of 81 on March 22, at his residence in Hyde Park Square, London. The previous day Mr. Morris had felt faint after his morning warm bath, and the next day he fainted in it, and, slipping under water, died from asphyxia following immersion before he was discovered. At the inquest the jury found a verdict of death by misadventure. Mr. Morris was well-known for many years by all those engaged in Parliamentary matters regarding tramways, and his loss will be deeply felt and regretted.

Glasgow Electricity Department Appointments.—At a meeting of the Electricity Committee of Glasgow Corporation, held on Tuesday, it was unanimously agreed to recommend the appointment of Mr. W. W. Lackie, chief assistant, to succeed Mr. W. A. Chamen as chief engineer and manager of the Electricity Department at a salary of £800, rising to £1,000. Mr. Lackie has been associated with the Glasgow Electricity Department since its establishment thirteen years ago. It was also agreed to recommend that Mr. Archibald Page, superintendent of the generating stations and sub-stations of the Electricity Department, be appointed chief assistant, in succession to Mr. Lackie, at a salary of £500.

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CONTRACTS AND ORDERS.

Messrs. Bruce, Peebles and Company, of Edinburgh, have received an order from Aberdeen Corporation for a 420-kw. dynamo.

Clarkson, Limited, of Chelmsford, have received an order from the colony of Victoria for four "Chelmsford" omnibus chassis.

Dover Corporation have accepted the tender of Messrs. Dick, Kerr and Company for four tramway cars at £575 each.

Bury Corporation have accepted the tender of Messrs. Siemens Brothers and Company for a 500-kw. generating set at £2,846.

Grimsby Corporation have accepted the tender of Messrs. Crompton and Company, of Chelmsford, for the supply of motors for two years.

Yarmouth Corporation have accepted the tender of Mr. J. Tidman for the purchase of 360 tons of discarded tramway rails at 40s. 7d. per ton.

Leith Corporation have accepted the tender of Messrs. A. Findlay and Company, of Motherwell, for the erection of the roof at Morton Place tramway depôt, at a cost of £2,220.

Stockport Corporation have accepted the tender of the British Thomson-Houston Company, Limited, for tramway cars with Brush bodies.

The Metropolitan Electric Tramways, Limited, have placed an order with Peter Brotherhood for an air compressor for car-cleaning purposes.

Callender's Cable and Construction Company, Limited, have received an order from East Ham Town Council for traction feeder cables at £247.

East Ham Corporation have accepted the tender of Messrs. Dick, Kerr and Company for five double-deck covered tramway cars, complete with electrical equipment.

Burslem Corporation have accepted the tender of Messrs. Grant and Son for the erection of electricity works and refuse destructor building at £3,745, and destructor chimney at £850.

Middlesex County Council have accepted the tender of Mr. C. Ford, at £6,711, for connecting the Archway Road and Finchley tramway lines with the Woodberry Grove car-sheds.

The Glasgow Railway Engineering Company, Limited, of Govan, Glasgow, have received an order from Stockport Corporation for ten sets of their pressed disc wheels with steel tyres.

Messrs. John Russell and Sons, of Wednesbury, have secured the order for poles for the Yarmouth Corporation Tramways extension, through the British Electric Equipment Company, Limited.

Mirfield District Council have accepted the following tenders:

Cables: Callender's Cable and Construction Company, Limited, London, at £832.
Meters: The British Thomson-Houston Company, Limited, Rugby, at £212.
Transformers: The British Westinghouse Company, Limited, London, at £204.

Pearson, Huggins and Company, Limited, of 51, Scrutton Street, London, E.C., have secured the contracts for the uniforms for the Great Northern and City Railway, the Chester Corporation Tramways, Airdrie and Coatbridge Tramways, and the Harlepool Electric Traction.

Messrs. W. R. Sykes' Interlocking Signal Company have received an order from the South Eastern and Chatham Joint Committee for the equipment of twelve miles of line between London Bridge and Grove Park with their system of electrical signalling, at a cost of about £7,000.

Ferranti, Limited.—Messrs. A. W. Tait and A. Whittaker, receivers and managers of Ferranti, Limited, inform us that under the scheme of reconstruction the new company was incorporated on February 27. From March 1 it carries on the business hitherto conducted by the receivers and managers.

Messrs. Wather, Gardiner and Company, of Staple Hill, Bristol, and 59, Gresham Street, London, E.C., have again secured the contract to supply uniforms to the Bristol Tramways Company, the Imperial Tramways Company, Middlesbrough, and the Bath Electric Tramways, Limited.

Messrs. Gawthorp and Company, of St. George's Sign Works, Leeds, have received an order from the Great Northern Railway Company, King's Cross Station, for their latest pattern railway late arrival indicator, which has given the authorities such satisfaction. They have also several orders in hand for their latest pattern departure indicator.

The Brush Electrical Engineering Company, Limited, have recently closed the following contracts:

Eight double-deck cars with radial trucks and Brush motor equipments, for the Leamington and Warwick tramways.
Overhead equipment for the Leamington and Warwick tramways.
Eight 500 kw. three-phase transformers for the county of Durham Electric Power Distribution Company.

Lancaster Corporation have accepted the tender of the British Westinghouse Company, Limited, for the supply of two tramcars at £570 each. In our issue of March 9 the name of the Corporation, by a clerical error, was given as "Leicester." The whole of the tramcars for the Leicester Corporation have, of course, been supplied by Messrs. Dick, Kerr and Company.

The J. G. Brill Company have received an order from the Boston Elevated Railway Company for 40 cars of the builders' patented semi-convertible type, mounted on Brill No. 27-E trucks. The cars are to measure 32 ft. over the bodies, and 8 ft. 4 in. over the sheathing of the straight sides; they are to have the new style of grooveless posts. The cars are for high-speed service on surface suburban lines.

Messrs. H. Lotery and Company, 4 to 8, St. Mary Street, London, N.E., report, among others, the following orders:

Croydon Corporation Tramways, the supply of the whole of the uniforms for the second year in succession.
Oldham Corporation Tramways, the whole of the uniforms required for inspectors, motormen, and point boys.
Bury Corporation Tramways, a renewal of the order for the supply of uniforms.

Messrs. Mountain and Gibson, of Elton Fold Works, Bury, inform us that the West Ham Corporation have approved and ordered thirty-five of their improved M. G. double-deck trolley standards, with poles and heads complete, for the new cars which are now being built. The order has been placed with Messrs. Mountain and Gibson through the Brush Electrical Engineering Company, Limited, who are building the car bodies.

The Brush Electrical Engineering Company, Limited, have recently closed the following contracts:

Three 50 kw. three-phase transformers, through C. H. Merz, for Sir W. G. Armstrong, Whitworth, and Company.
Complete steam and electrical plant for power-house, for the Leamington and Warwick Tramways.
Three double-deck cars, with radial trucks and British motor equipments, for Airdrie and Coatbridge Tramways.

Hurst, Nelson, and Company, Limited, during the last few weeks have secured the following contracts, amongst others:

Perth Corporation Tramways, 12 complete four-wheel double-deck cars and trucks.
Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board, 12 car bodies.
Mansfield and District Light Railway, 12 car bodies and trucks.
Kilmarnock Corporation Tramways, repeat order for 2 top-deck covered four-wheel cars and 1 four-wheel double-deck car.

The Electric Tramway Equipment Company (Alfred Wiseman), of Birmingham, are exceptionally busy in all their departments. For orders which they have at present on hand they have just sent large consignments to Mexico, South America, South Africa, Australia, New Zealand, and China. These orders are for overhead line material. In the gear-cutting department the company has been working a night and day shift for over a year, and although they have doubled their gear-cutting plant recently the department is still fully employed.

S. Dixon and Son, Limited, have on hand a number of orders for the supply of Turner's patent automatic point controller. They have recently installed this apparatus on the Manchester, Rotherham, and Leicester Corporation Tramways, and are at the present time fixing eight on the West Ham Corporation Tramways. They have also received a third repeat order from the Leeds Corporation Tramways for four controllers, so that this apparatus, for which there has long been a demand, appears to have taken a firm place on the market.

Messrs. Bruce Peebles and Company, of Edinburgh, have received an important electric motor contract from the Lancashire Electric Power Company for large alternating-current motors. The Lancashire Power Company, supplying, as it does, electrical power throughout the densely-populated industrial district of Lancashire, has in prospect an enormous business. Messrs. Bruce and Peebles have also secured an order for an 800 H.P. dynamo for the Leith electric tramways, and for three 800 H.P. patent motor converters for Manchester Corporation.

Messrs. Graham, Morton and Company, of Leeds, have secured the contract for the supply of a complete ash-elevator plant for the boiler-house of the Islington Urban District Council. The elevator is driven by means of a 3 B.H.P. motor running at 500 revolutions per minute.—The same contractors recently secured an order for the installation of an extensive boat-loading plant for Seaham Harbour. By an arrangement of the eight coal shoots constituting part of the design, allowance is made far the rising and falling of the boats occasioned by the tide.

Messrs. H. Lotery and Company, of 4 to 8, St. Mary Street, London, N.E., have recently received amongst others, the following contracts:

Leicester Corporation Tramways, 400 suits for motormen, conductors, and point boys.
Exeter Corporation, uniforms for the whole of the employees of the electric tramways.
Oldham, Ashton, and Hyde Electric Tramways, Limited, a renewal of the contract for 12 months for the supply of uniforms.
Walthamstow Council Tramways, supply of uniforms.
Barrow-in-Furness Tramways Company, supply of uniforms.
London and India Docks Company, supply of uniforms for three years.

Chelmsford Steam Omnibuses.—Messrs. Clarkson, Limited, of Chelmsford, inform us that the Torquay and District Motor Omnibus Company have purchased three more of the "Chelmsford" steam omnibuses. The order was placed after an experience of about

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eighteen months with five similar 'buses built by Messrs. Clarkson. One of these five omnibuses ran nine weeks without intermission before the delivery of the second. The Torquay and District Motor Omnibus Company was, it will be remembered, one of the pioneer motor omnibus companies of this country, and recently paid a dividend of 7½ per cent. after twelve months' operation.

Graham, Morton, and Company, Limited, engineers and contractors, of Leeds, have received a contract for the construction and erection of a large warehouse at East Quay, South Dock, for the Alexandra (Newport and South Wales) Docks and Railway Company. The building is to be 200 ft. long and of 70 ft. span, and the whole of the ironwork will be in position eight weeks from the date of the order. This, of course, consists of roof-principals, purlins, rivetted compound steel girders, rolled-steel girders, the usual gutterings, etc., and a specified number of casements constructed to open in the centre. All steel used in the construction is to be of the best quality mild steel.

Derby Corporation Tramways Committee have received the following tenders for the construction of the permanent way and electrical equipment of the Kedleston Road and Walbrook Road tramway routes:

	£	s.	d.
W. Griffiths and Sons, London	18,689	2	9
A. Kraus and Son, Bristol	18,883	0	0
Brush Electrical Engineering Company, Limited, Loughborough	18,892	8	5
G. F. Tomlinson, Derby	19,097	16	10
G. Holloway, Wolverhampton	19,314	4	4
W. Underwood, Dukinfield	19,448	3	10

The Committee have decided to recommend the Council to accept the tender of Messrs. W. Griffiths and Sons, and also to recommend the acceptance of the tender of the Brush Electrical Engineering Company, Limited, Loughborough, for the supply of four new cars.

FINANCIAL REPORTS.

Dartford Tramways Scheme. Negotiations have been completed by the Dartford Urban District Council for a loan of £93,000 for the construction of tramways linking the town with London, 17 miles distant. The terminus is near the site of the new Great Ocean Wharf for the Port of London.

Glasgow District Subway Company.—The directors recommend the following dividends: On the 4 per cent. preference shares at the rate of 4 per cent. per annum, on the ordinary shares at the rate of 1¾ per cent. per annum, carrying forward £1,003 15s. 9d. The dividend a year ago was at the rate of 1¾ per cent. on the ordinary shares, carrying forward £841 3s. 8d.

Hadfield's Steel Foundry Company, Sheffield.—The annual report states that the profit amounted to £76,866, making, with the amount brought forward, £92,107. A final dividend of 2s. per share, and 1s. 6d. per share bonus, making 22½ per cent. for the year, is recommended, leaving £15,607 to be carried forward. The whole of the additional issue of 50,000 £1 ordinary shares offered at 30s. premium were taken, and the premiums were added to reserve, making this £195,000.

Keighley Corporation Tramways. The Tramways Committee have prepared a report, giving particulars of the revenue since the opening of the system. The receipts from October 12 to February 25 amounted to £2,108 8s., or 6·99d. per mile, and the number of passengers carried was 498,982, or 6 89 to a mile. The current consumed totalled 79,138 units, at a cost of £659 9s. 8d., or 2·18d. per mile. About £835 had been paid in wages, or 2·77d. per mile.

Bruce, Peebles, and Company, Limited. The report for the year ended December 31 last states that the available balance at credit of profit and loss account is £29,146. The directors recommend a dividend at the rate of 6 per cent. per annum on the ordinary shares, the transfer of £2,879 to the preference shareholders' special reserve, and £7,000 to the general reserve, and that £4,000 should be written off preliminary expenses. There will then remain £3,854 to be carried forward.

Underground Electric Railways. At a special meeting of the shareholders of the Underground Electric Railways Company of London, Limited, held on March 2, the chairman (Mr. Charles T. Yerkes) stated that the company, having sold £2,500,000 of debentures of the Baker Street and Waterloo Railway Company, the Great Northern, Piccadilly, and Brompton Railway Company, and the Charing Cross, Euston, and Hampstead Railway Company, the shareholders would not be asked to sanction the proposed increase of the borrowing powers of the Underground Company.

Southampton Corporation Tramways. The borough treasurer has prepared a financial estimate for the Tramways Committee. The income for the year ending March 31, 1906, it is estimated at £51,609, which sum compares with £55,618 estimated for 1905, and with £50,571 9s. 7d., the income actually derived for the year ending March, 1905. The working expenses for 1906 are fixed at £34,847, compared with £37,248 (estimated) for 1905, and with £36,197 14s. actually incurred for the twelve months ending March 31, 1905. The estimated balance to be transferred to the depreciation and renewals fund is £5,678.

Peebles Steam Car Company, Limited. This company was registered on March 4, with a capital of £30,000, in £1 shares (15,000 preference). Objects: To adopt an agreement with Bruce, Peebles, and Company, Limited, and the Electric Conversion Syndicate, Limited, and to carry on the business of manufacturers of steam, electric, petrol, or other engines, railway carriages, and wagons, cars, locomotives, etc. No initial public issue. The directors are to number not less than three or more than five Bruce, Peebles, and Company, Limited, the Electric Conversion Syndicate, Limited, and H. G. V. Adler have the right to nominate three directors. Registered office, 25, Victoria Street, Westminster.

British Insulated and Helsby Cables.—The report for the year ended December 31, 1904, states that the profit for the year amounted to £129,817, to which has to be added the balance brought forward £6,165, making £135,982. The directors recommend a further dividend of 4 per cent. on the ordinary shares, making 8 per cent. for the year, carrying forward £7,114. The volume of trade has been large, but competition still continues very keen. A further sum of £8,500 has been added to the special reserve account. Additions to new plant and machinery, etc., during the year at the Prescot, Helsby and Liverpool Works have been necessitated in order to facilitate the company's business, and widen the scope of its operations.

W. T. Henley's Telegraph Works Company, Limited. During 1904 a net profit was made of £46,521. After payment of directors' and auditors' fees, debenture interest and income tax, and making the usual allowance for depreciation of buildings, plant, machinery, etc., there remains £38,263, making, with £27,585 brought forward from last year, a total of £65,849. The directors have transferred £1,000 to the debenture redemption sinking fund, and they recommend the payment of a dividend on the ordinary shares at the rate of 15 per cent. (less income tax), including the interim dividend of 5 per cent. paid on September 1 last. These payments will, together with the preference dividend for the year, amount to £39,337, leaving a balance of £26,511 to be carried forward.

London, Deptford, and Greenwich Tramways Company, Limited.—This company was registered on March 11 with a capital of £170,000, in 17,000 preferred half shares and 17,000 deferred half shares of £5 each, being a re-incorporation, under the Companies Acts, 1862 to 1900, of the concern originally constituted by the Southwark and Deptford Tramways Act, 1879, and further governed by the Southwark and Deptford Tramways Acts, 1881 and 1889, and the London, Deptford, and Greenwich Tramways Acts, 1891 and 1893. At the date of conversion into a limited company, 12,989 preferred half shares and 12,989 deferred half shares had been taken up, and £5 had been paid up on each. The resolution authorising the directors to convert this concern, with a view to the distribution of the assets, so soon as the transfer of the property to the London County Council should be completed, was passed on August 9, 1904.

Mersey Railway Company.—The report for the half-year ended December 31, 1904, states that the train mileage run during the half-year was 415,625 miles, as compared with 401,046 during the corresponding six months of 1903. The number of passengers conveyed during the half-year has been 4,657,876, as against 4,153,777 for the corresponding period of 1903, exclusive of season-ticket holders. The total receipts from all sources have been £41,789, as compared with £37,358 for the corresponding period of 1903. Working expenses, exclusive of the exceptional charges for pumping, ventilation, and lifts, have been £2,029, equal to 69·17 per cent., as against £28,203, equal to 75·50 for the corresponding six months. These exceptional charges for pumping, ventilation, and hydraulic lifts for the past half-year amounted to £3,854, equal to 9·22 per cent., as compared with £4,237, or at the rate of 11·34 per cent., for the corresponding period of 1903.

Oldham, Ashton, and Hyde Electric Tramway.—The report states that the total revenue for the year amounts to £29,349, and expenditure (including £1,600 for debenture interest) to £22,877, leaving a profit of £6,472, which, added to £170 brought forward from the previous account, makes an available balance of £6,642 The directors propose placing to depreciation and reserve fund £1,000, and, after paying a dividend on the ordinary shares at the rate of 7 per cent. per annum for the six months ended December 31, 1904, making 6 per cent. for the year, leave to be carried forward £142. The subscribed share and debenture capital of the company is £140,000. The total capital expenditure to December 31, 1904, amounts to £153,668. With the addition of the £1,000 proposed above the depreciation and reserve fund will amount to £9,748 5s. 9d. A satisfactory agreement has been entered into by which the Corporation of Ashton-under-Lyne will continue to supply the electrical energy for the working of the tramway.

Leicester Corporation Tramways.—The Tramways Committee have submitted a report and statement of accounts of the tramways undertaking during the year 1904. This shows that the gross receipts in excess of expenditure (including a sum of £776 4s. for bank interest) amounts to £31,908 4s. 5d. The interest and sinking fund charges in respect of the old tramway undertaking purchase, and the interest on additional capital for the electric tramway works, amount to £18,849 9s. 8d., and there is consequently a net credit balance of £13,038 14s. 9d. The committee, in their report, remind the Council that by the

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Leicester Corporation Act, 1902, a reserve fund not exceeding £100,000 is authorised to be provided to meet deficiencies at any time happening, or to provide new plant, or for renewing new works, or to meet any extraordinary claims, etc., and they are of opinion that, in view of the anticipated heavy wear and tear, and to meet contingencies, it is advisable that the whole of the surplus should be placed to this fund, which course they have determined to adopt.

City of Oxford and District Tramways Company. The report states that the receipts for the year ended December 31 last were £16,683, and expenditure £13,980, leaving a profit of £2,703. Including last year's balance of £221, there is a total to be dealt with of £2,924. The interim dividend of 2 per cent. paid in July last absorbed £800, leaving a balance of £2,124. The directors recommend a further dividend of 4 per cent., which will absorb £1,600, leaving £524 to be carried to the next account. In 1902 the value of the tramcars was reduced from their cost-price by £992 from the reserve fund for depreciation, and it was decided last year to replace this amount by two equal yearly charges to profit and loss; the sum of £496 was therefore charged to loss on tramcars account, making the reserve £8,537, and by a similar transfer in the accounts now submitted the reserve fund for depreciation is restored to its original amount. The alterations contemplated and referred to in the last year's report, which the directors considered would have been a great convenience to the public, were not carried out in consequence of the Oxford City Council withholding its consent. Without additional passing-places it was difficult to continue the increased service.

National Electric Construction Company, Limited.—The annual meeting was held on March 24 in London, Mr. R. Stewart Bain presided. The chairman said that twelve months ago he had to regret the result of the year's work, which showed a loss of nearly £4,000. He was glad to say, however, that several important contracts had been completed during the year, and instead of a loss there was a very substantial profit of nearly £20,000. The Musselburgh tramways, opened in December last, carried up to March, 9,425,334 passengers, and the directors were of opinion that this undertaking would prove a most valuable property. As to the future, the prospect was distinctly favourable. In addition to the contracts he had mentioned, they had just concluded two agreements, one for laying down an electric tramway in a town on the south coast, and another for taking over an electric lighting and tramway order in the Midlands, both of which it was believed would prove highly profitable, and would occupy the Company for the next 18 months. In addition, they intended to apply for powers to extend the Musselburgh tramway along the coast, and to construct a tramway between Edinburgh and Queensferry. He congratulated the shareholders on the change that had come about in their fortunes. The report was unanimously adopted.

Swansea Improvements and Tramways Company. The report for the half-year ended December, 1904, shows that the receipts were £15,361, a decrease of £124 on the corresponding period of last year, and the expenses £10,598, an increase of £476. The profit on the half-year's working is £4,763, which, added to the balance of £2,773 brought forward, makes a total of £7,536 to the credit. The directors pay a dividend of 6 per cent. on 984 preference shares, 5 per cent. on 4,016 preference shares, and 2½ per cent. on 13,000 ordinary shares, and carry forward £1,987 10s. 4d. The working of the Mumbles Railway and Pier Company shows a profit of £1,362, which, deducted from the deficiency of £2,668 for the half-year ended June 30, 1904, leaves a net deficiency of £1,305 16s. on the year's working. This is to be provided by the British Electric Traction Company. During the year the Clyne Valley railroad has been reconstructed at a cost of £1,100, and a considerable revenue is expected from the coal traffic from the recently opened colliery. The net loss on the improvements concern for the half-year is £621, of which £349 consists of interest on mortgages, and the bulk of the remainder on expenses in connection with the Palace Theatre of Varjeties. During the half-year 2,902,297 passengers were carried, as against 2,896,784 during the 1903 half-year.

Poole and District Electric Traction Company, Limited. The annual report states that the additional outlay on capital account during 1904 has amounted to £1,389, and the total capital expenditure to December 31 last stands at £69,151. The total receipts from January 1 to December 31, 1904, amounted to £15,673, and the expenses, including £461 for loan interest, to £10,791, leaving a profit of £4,881, to which should be added £628 brought forward, making £5,509 available for distribution, which the directors recommend should be applied as follows: To pay a dividend at the rate of 10 per cent. for the year, £5,000; to carry forward £509. During the past year the number of passengers carried exceeded that of the previous year by 46,124, but whilst more passengers travelled over short distances, there was a marked falling-off in the number of passengers who travelled the whole distance between Bournemouth and Poole. Early last year efforts were made to agree with the Corporation of Bournemouth as to the price to be paid for the undertaking. These efforts were not successful, and it consequently became necessary to refer the matter to arbitration. The hearing occupied ten days, during the period between May and October last, and in December the umpire issued his award, which, as the shareholders have already been advised, amounted to £112,000, excluding various agreed sums. Other points arising out of the agreement for sale to the Corporation remain to be settled by another arbitration, but the directors estimate that in any case the distribution which the purchase price will allow will be not less than £17 per share.

Imperial Tramways Company, Limited.—At the annual general meeting of this Company, Sir George White, who presided, said the accounts were of a completely satisfactory character, except in one small particular—that was the dividend earned on the Corris railway, which was at the rate of 4 per cent. upon ordinary stock owned by them, against 6 per cent. in 1903. That was due to the curtailment of operations at an important slate quarry, through an accident. In all other items he had nothing but improvement and progress to report. The Middlesbrough, Stockton, and Thornaby electric tramways showed a net profit of £16,564, against £16,353, in addition to which they had added £1,400 to the Middlesbrough renewal fund. They had obtained powers to continue their existing system at Middlesbrough and to run through the populous manufacturing districts of North Ormseby, South Bank, Grangetown, and Eston. The new Act included authority to convert from single to double lines adjacent to the Stockton Racecourse. After referring to the amount of stock the company held in the London United Tramways Company, he said that though, consequent upon heavy outlays upon capital account, the good, round dividend of 6 per cent. fell short of that for 1903, he congratulated the directors of the London United on having made a profit of £120,000 last year, against £103,000 in 1903, about a fifth of which profit accrued to the Imperial Company in preference dividend. The net profit of the Imperial Company for the year was £41,655, and, after the 6 per cent. dividend on preference capital, it was proposed to pay a dividend at the rate of 10 per cent. on the ordinary stock, making 9 per cent. for the year. The company's reserve fund now amounted to £121,871.

Perth (W.A.) Electric Tramways, Limited. The report of the Perth (W.A.) Electric Tramways, Limited, for the year ended December 31, 1904, states that gross receipts for the year amounted to £69,411, yielding a profit of £29,360, an increase of £6,389. From January 1 to March 10, 1905, the gross receipts show an increase of £1,208, compared with the same period of 1904. After paying interest on the first and second debenture issues, the sinking fund for the first debenture stock, and the trustees' fees, the balance standing to credit of profit and loss account is £14,181, which is carried to profit allocation account. To this sum is added the balance brought forward from last year - namely, £3,232—and £500 proportion of interest on guaranteed deposit, making £17,912, from which has to be deducted £9,000 for preference dividends (paying all arrears to date) and £450 dividend-tax in Western Australia. A balance is thus left of £8,463, of which £500, accrued interest as above, is payable to the trustees for the debenture holders, leaving a balance of £7,963. The directors now propose to add £5,000 to reserve account, leaving, with the £500 referred to above, a balance of £3,463 to be carried forward. The directors consider it prudent now to provide a cash reserve of £5,000 in addition to the reserve stock of stores and material. To meet the increasing demands for traffic accommodation it is necessary for the company to again provide additional cars; five are required immediately, and delivery will be hastened so as to take advantage of the heavy traffic in the next hot season. On the recommendation of the company's representatives in Perth, a concession has been obtained for extending the system to North Perth, which will add about 1 mile to the existing mileage. In addition to this the company has made an agreement with the Victoria Park Council for leasing a tram-line connecting the existing system with the growing suburban district of Victoria Park.

London Power Omnibus Company, Limited.—The prospectus of this new company was issued early in March. The capital is £200,000, in shares of £1 each, the whole of which were offered. The directors are Mr. G. C. Montague, M.P., the Hon. F. C. Stanley, Mr. T. F. Thompson, Captain H. H. P. Deasy, and Mr. N. D. Macdonald. The prospectus states that it is proposed to run single-deck petrol motor 'buses to seat sixteen passengers each, and also double-deck 'buses to seat thirty-two passengers. A contract has been entered into with Messrs. Scott, Stirling and Company, of Hamilton, Lanarkshire, for the supply of fifty single-deck 'buses and a like number of double-deck 'buses. The price payable for these vehicles is £67,756. The company have an option with the builders of the 'buses to enter into a maintenance contract, whereby the builders for 3¼d. per mile run for the single-deck 'buses and 4½d. per mile run for the double-deck 'buses, undertake to maintain, repair, and keep the 'buses in good running order, including the renewal of tyres for ten years. The company will purchase the eight omnibuses of a smaller company hitherto existing, of the same name, for £6,000, and acquire a tenancy of a depôt. The smaller company has been running motor 'buses experimentally for a year. The prospectus also gives an estimate of revenue and expenditure for the working of 100 'buses. The revenue per annum is put at £107,219, and the expenditure at £82,858, leaving a balance of £24,360, the expenses including insurance and 12½ per cent. per annum for depreciation. The purely working expenses per mile run are thus given: For single-deck 'buses, fuel ¾d., drivers and conductors 2d., maintenance

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contract 3¼d., total 6d. For double-deck 'buses, fuel 1½d., drivers and conductors 2d., maintenance 4½d., total 7¾d. It will be noted that general charges are not included in these expenses. Of the total issue of shares 100,000 are underwritten. All capital subscribed for above the first £100,000 will be available for the purchase of additional omnibuses.

London and District Motor 'Bus Company, Limited.—A prospectus of this company was issued on March 9. The capital is £405,000, divided into 400,000 ordinary shares of £1 each and 100,000 deferred shares of 1s. each. The present issue is of 250,000 ordinary shares. The profits available for dividend are to be applied first in payment of a dividend of 10 per cent. on the ordinary shares, and any balance remaining is to be equally divided between the holders of the ordinary and the deferred shares The directors are Mr. A. A. Campbell Swinton, director of the Bath Electric Tramways, chairman; Mr. J. F. Albright, director of the Gravesend and Northfleet Electric Tramways; Mr. E. Caillard, director of the Sunderland District Electric Tramways Company; and Sir A. Compton-Thornhill. The prospectus states that Mr. W. Worby Beaumont, hon. consulting engineer to the Automobile Club, has agreed to act as consulting engineer to the company, and has reported to the following effect: The motor omnibus can be run in commercial practice on an average at least 90 miles per day. He is satisfied that after allowing 20 per cent. per annum for depreciation and charging all running and maintenance to revenue motor 'buses can make a net profit of at least 2d. per mile run. This profit may in the near future be expected to reach 3d. The prospectus proceeds to say that the proceeds of the present issue of shares should enable the directors to acquire at least 200 motor 'buses and provide the necessary garages and leave an ample margin for all further requirements. The directors, on Mr. Beaumont's estimates, put the profit per 'bus per day at 15s. This, on 200 'buses running 300 days per year, would produce a profit of £45,000. A dividend of 10 per cent. on 250,000 ordinary shares would absorb £25,000, leaving a balance for administration and further dividends of £20,000. An agreement has been made with the Motor Omnibus Construction Company to supply this company with chassis, while the Dunlop Rubber Company have entered into a provisional contract to supply tyres for two years. It is intended to work in close alliance with the London Motor Omnibus Company. The New Motor Syndicate are the promoters, and they are to be paid £7,500, and to receive the whole of the deferred shares issued as fully paid. Of the present issue of ordinary shares, 50,000 were underwritten.

London United Tramways (1901), Limited.—The annual meeting was held at Chiswick on February 28, Mr. Charles T. Yerkes, the company's chairman, presiding. The chairman, in moving the adoption of the report, said that the company had already derived much benefit from the conversion to double track of a number of lengths of single line on the Hampton Court route. The capital outlays which had been made increased the interest and preference dividend charges very substantially, but the board were confident that it would not be long before the company reaped the full benefit in a speedier development of its business and a corresponding increase in revenue. The traffic receipts showed every sign of a steady increase. Their working had now been standardised so as to secure the maximum of economy consistent with efficiency. Since their last meeting the line from Southall *via* Hayes and Hillingdon to Uxbridge, and also the connecting line from Hammersmith Broadway *via* Askew Road, had been put successfully into operation, and the result of the working since June last had fully realised anticipations. A very large development of traffic would, the directors believed, rapidly take place along the fine stretch of country between Southall and Uxbridge. The company had now 37 miles of electric tramways in operation, against about 30 miles last year; but, though the mileage had increased, there was no advance in expenses. The directors were concluding contracts for building and equipping the authorised extension of the company's system in Kingston, Surbiton, the Maldens, and Wimbledon, and between Brentford and Hanwell. It was expected that the lines would be completed and put into operation during the course of the year. He concluded by moving the adoption of the report, which was seconded by Mr. J. Clifton Robinson In the course of a brief discussion one shareholder suggested that it would be advisable to increase the reserve fund, especially in view of the advent of motor-omnibuses. In reply, the chairman said the present fund might be regarded as a nucleus. He had not much faith in the motor-omnibus himself—if he had he should most likely have busied himself about it—although he should not wonder if it took the place of the horse-omnibus for a while. The motion having been adopted, Mr. W. H. Brown (of Messrs. Speyer Brothers) was elected a director in the place of Mr. S. White, and power was taken by resolution to increase the number of the board to seven, Mr. Yerkes announcing that his business engagements were now so heavy that he contemplated retiring from the chairmanship of the company, though retaining a seat on the board. Incidentally it was mentioned that the receipts during the past two months had increased by £2,056, while the working expenditure had remained stationary. An extraordinary general meeting was held subsequently, when two bills now before Parliament affecting the interests of the company were approved.

TRAMWAY & LIGHT RAILWAY NOTES.

BECKENHAM.—The Urban District Council have definitely decided, by 12 votes to 5, to abandon the scheme of tramways for the construction of which an Act of Parliament was obtained two years ago. Recently proposals were made to abandon the agreement with the British Electric Traction Company in favour of another in which the company were to provide, if possible, a service of motor 'buses from the termination of the Penge tramways, to cover the costs of the Beckenham Act of Parliament, and to refrain from promoting, or assisting to promote, a Bill for tramways in Beckenham for ten years. This change of front has caused a good deal of dissatisfaction among the ratepayers. While a Council meeting was being held on March 20, a number of ratepayers who were in favour of the tramways assembled in large numbers outside the building. A deputation which was formed to wait upon the Council was admitted and their case was stated. The adherents, however, of the tramways were out-voted by a large majority.

BELFAST. At a meeting of the Tramways and Electricity Committee, on March 13, Mr. Nance, the tramway manager, submitted a report on the question of top-covers for tramcars, in which he expressed the opinion that a decision in this matter should be deferred until after the complete installation of electric traction in the city. Mr. Nance gave the following reasons for postponing the adoption of top-covers: "That up to the present no top-cover had been perfected; that there would undoubtedly be many improvements introduced during the next twelve months; and that by deferring the matter until after their car building and repairing department was fully equipped they could, if it ever should be decided to introduce covers, do the work at two-thirds the cost of having it done by contract, and it would be carried out entirely by local labour." It was decided that the matter should be postponed until electric traction was an accomplished fact in the city.

BIRMINGHAM.—Following the example set by the Birmingham Motor Express Company, three motor-cars have been placed on the streets of Birmingham by the City of Birmingham Tramway Company, Limited. They commenced to run on the Harborne route, but other sections are to be equipped with similar vehicles, the intention being to replace some twenty-five horse 'buses by motors. The cars are built to carry thirty-six passengers, are of a very powerful type—an important feature being that they are of fireproof material and they have the further advantage of being almost noiseless. The chassis are of the Dukopp type, and the entire vehicle will cost something like £800 to £900. The local authority having already sanctioned the running of motor 'buses no difficulty was experienced in obtaining the requisite permission. The Birmingham public have, on the whole, taken kindly to the new vehicles, and as there is still a considerable 'bus traffic there is ample scope for further enterprise in the new direction. The whole of the vehicles are being built by the Brush Company, Loughborough. The Tramways Committee recently instructed their manager, Mr. A. Baker, to prepare specifications for 200 four-wheeled cars, double-decked, but without top covers. Owing to the gradients on the line to be taken over by the Corporation, bogies were deemed inadvisable, and the cars will, therefore, not seat as many passengers as the Aston cars. The top covers have been omitted in deference to the Board of Trade, as the lines are on the 3 ft. 6 in. gauge, on which, in their wisdom, the authorities consider such top covers are dangerous. The objectionable pitching to which some four-wheeled cars are often subject will, it is believed, be entirely obviated in the new cars. Tenders were invited early in March for the 200 cars and are to be sent in to-day.

BLOEMFONTEIN.—At a recent meeting of the Bloemfontein Town Council, application was made for a concession for running a system of motor 'buses. The Public Works Committee fully considered the matter, and arrived at the conclusion that nothing short of a complete system of electric tramways would meet the needs of the city, especially in view of the growth of the suburban population. The Committee recommended the Council to call for tenders for a concession for electric tramways. The motor 'bus application accordingly fell through, the Council deciding to invite applications for a concession.

BRADFORD. The Mayor of Bradford a few days ago presented a number of tramcar drivers and conductors, who had distinguished themselves for their pluck in different accidents, with cheques ranging from £3 to £5.

BURTON.—The Gas and Electricity Committee of Burton-upon-Trent have instructed the borough electrical engineer and tramways

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manager, Mr. P. J. Pringle, to obtain tenders for a 100 KW. continuous-current dynamo, together with the necessary switchboard and connections. The new generator is required to deal with the additional service of cars required for the Burton and Ashby light railway. Messrs. Kincaid, Waller, Manville, and Dawson, the consulting engineers, are preparing the specifications for track work in the borough to connect with the Burton and Ashby light railway.

CARDIFF.—Mr. Arthur Ellis, manager of Cardiff Corporation Tramways, has recommended the Tramways Committee to appoint a medical man to examine the men in their employment. Mr. Ellis at present finds it necessary to keep no fewer than forty men in reserve to take the places of those who fall sick. He instanced a case in which a man who had only been employed for six weeks became ill and was thus entitled to 50 per cent. allowance. The committee have instructed Mr. Ellis to inquire into the practice adopted in the employment of medical men by other departments of the Corporation and make a report.

CHELTENHAM.—The work of extending the light railway to the two principal suburbs of Cheltenham, viz., Leckhampton and Charlton Kings, has now been completed. The system has already for nearly four years extended from beyond the Midland Station on the extreme south west of the town to the top of Cleeve Hill, a distance of about six miles, and by the extensions now made some four or five miles of running has been added.

DUNEDIN. — Messrs. Noyes Brothers, electrical engineers, of Australasia, who are the consulting engineers to the Dunedin City Corporation in connection with the electrification of the tramways, are now proceeding with the installation of the water-power generating plant for the city of Dunedin. The water-power to be utilised has a fall of 700 ft. in less than 2 miles, and there will be 6,000 horse-power available. The power-house will be situated about 32 miles from Dunedin, and the power will be transmitted at 30,000 volts. Two 1,000 KW. units are being installed, each being connected to Pelton wheels. It is anticipated that the scheme will be in operation about the end of this year.

EDINBURGH AND DALKEITH.—Application is now about to be made for a Provisional Order for the incorporation of a company to be known as the Edinburgh Suburban Electric Tramways, for the purpose of laying down tramways between a point twenty yards south east of Craigmillar Park, at the junction with the Edinburgh and Dalkeith roads, and passing thence by Greenend to Gilmerton, and along by the Dalkeith road to Eskbank Then by a junction with the former line the tramways will proceed to Bonnyrigg, terminating at the boundary of the Bonnyrigg burgh with Lasswade burgh. Another line will proceed along Eskbank Road to Dalkeith, ending 135 yards from the entrance gates to Dalkeith House.

HALIFAX.—After hearing the report of the deputation which attended the exhibition of motor 'buses held in London, the Halifax Tramways Committee have resolved to recommend the Town Council to obtain, if possible, by August, a couple of the Milnes-Daimler petrol-omnibuses. Each 'bus will cost £950, and will seat thirty-six passengers. In the Halifax district there are several places desirous to have improved communication with the town by means of tramway extensions, but, owing to the cost, this has not been so far possible. The Tramways Committee believe that the difficulty can be overcome by the introduction of motor omnibuses. For instance, the Corporation tramcars run from the centre of Halifax to Pellon. The distance from this place to Mount Tabor and Wainstalls, outlying portions of the borough, is about two miles, which could easily be covered by the omnibuses.

HUDDERSFIELD.—The Corporation have refused an application from the tramway employees for a week's holiday each year, and have postponed an application for extra pay for Sunday labour until the tramways are self-supporting.

LIVERPOOL.—The second annual social and dance of the Liverpool Corporation Tramway Employees' Social, Athletic, and Thrift Society, took place on March 21, in St. George's Hall, where about 1,000 employees were present with friends. Mr. C. R. Bellamy, the general manager, presided, and submitted the annual report of the society, which stated that the organisation, which has only been in existence two years, has a membership of 1,700, an income of £2,500 a year, and an expenditure of £2,300. The members of the society who were precluded by duty from attending were similarly entertained on the following night.

MUSSELBURGH.—On March 4 there came into operation an increased and accelerated train service between the Waverley Station, Edinburgh, and Musselburgh, which has doubtless been conceded owing to the competition of the new electric tramways from Joppa to Musselburgh. On Saturdays there are now about thirty trains running each way, and a considerable number are run at an accelerated rate, some of them completing in ten minutes the journey which used to occupy half-an-hour. A reduction of fares also took effect.

NEWCASTLE.—The Tramways Committee on March 9 decided to recommend the Council to proceed at once with a tramway extension, 2½ miles in length, from the present terminus at Scotswood to the Scotswood Suspension Bridge. The cost of the extension is estimated at £23,000.

PAISLEY.—At a meeting of Paisley Town Council, on March 14, it was resolved that, on the understanding that children's fares be conceded within ten days after intimation by the Council of their withdrawal of their opposition to the Paisley District Tramways Provisional Order, the Council agree to withdraw their opposition, subject to the understanding that the company will grant their obligation to the effect that, in the event of the authorities of the Houses of Parliament, or of Parliament itself, refusing to allow the clause as to children's fares to be introduced into the Order, the company will, notwithstanding, allow children to travel upon their cars for all time coming in terms of the proposed clause.—Glasgow Corporation commenced through running to Paisley on March 20. The Paisley and District Tramway Company, according to agreement with the Glasgow Corporation, have withdrawn their cars from the eastern section of the Paisley system, between Hawkhead Road and Paisley Cross.

PERTH.—The deputation sent some time ago by the Perth Corporation Tramways Committee to visit Ayr, Paisley, Motherwell, Glasgow, Dundee, Kirkcaldy, etc., with a view to obtaining information with regard to the electric tramway service in those towns, have presented their report. They recommend outside ribbed seats, mechanical bells, Fisher's patent life-guards, Stanwood folding steps, ordinary staircases, and Messrs. Saxby and Farmer's signals. The deputation also recommended the purchase of a tower wagon from Messrs. Hurst, Nelson, and Company.

PORTSMOUTH.—The Portsmouth Corporation have issued an official handbook and illustrated map of their electric tramway routes, under the signature of Mr. W. R. Spaven, the general manager of the tramways. The pamphlet is a well-printed little brochure of 40 pages, and contains among other useful matter a page of "hints to passengers," the tramway by-laws, illustrations of Portsmouth cars, with a brief description of the tramway system. The time-table of the various services is accompanied with notes relating to central places of interest and attractive tramway rides. The map is clearly printed in colours, and the whole pamphlet will be specially useful to visitors, and should add to the tramway revenue.

SINGAPORE.—Mr. Lewis D. Tandy, whose appointment as manager to the new Singapore Electric Tramways was announced in our issue of January 21, arrived at Singapore on February 15, and immediately took over the control of the undertaking. A despatch from Singapore a week later stated that the construction had so far advanced that the opening ceremony was expected to take place on March 15. The cars were exported from Europe in sections, and were put together at the tramway company's car sheds. A feature of the power-station is the steel chimney, which reaches a height of 125 ft. The Hong Kong Electric Tramways, which were completed last July, are said to be drawing £500 a month. Singapore optimists hope to overtop this figure by 50 per cent.

SOUTHPORT.—The Southport Pier Tramway, which has hitherto been worked on the cable system, has now been electrified. The pier is over a mile in length. The electrification was undertaken by the British Westinghouse Electric and Manufacturing Company, Limited. The system employed is the third rail supply with a track rail return, the current being supplied at a pressure of 500 volts. Two 30 H.P. motors are employed on the motor coach, which will run either singly or coupled to one or both of the trailer coaches, as the amount of traffic demands. The train can be controlled from either the motor coach or the trailers, a controller being placed on either end of the motor coach and one on each of the trailers. The car lighting consists of ten 100 volt lamps per coach, these being arranged in groups of five in series. The equipment is British made throughout.

SUNDERLAND.—The Sunderland and District Tramways are expected to be open for traffic within the next two months. The lines, which are about twelve miles in length, run through a district which is one of the most important centres of the coal trade in the kingdom.

YARMOUTH.—As the result of the arbitration, held on the application of the Yarmouth Town Council, to determine the price to be paid on compulsorily acquiring the tramway running between Yarmouth and Gorleston, Mr. Graham Harris, who was the arbitrator appointed by the Board of Trade, has announced his award. He fixed the amount which the Corporation is to pay at £13,400, together with the cost of the fodder in stock at the depôt, which is taken over with the cars, all plant and equipment; and the Corporation is further to pay the tramway company's legal costs. The Corporation had been asked to pay £19,000 for the undertaking, which is a single line, dating back to 1882. The Corporation intend relaying the track, erecting overhead equipment, and running the cars by electricity. On March 11 the lines passed into the hands of the Corporation. The cost of conversion is estimated at £45,000.

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NEW PUBLICATIONS.

Engineering Standards Committee and Marine Boilers.—The Engineering Standards Committee have issued their British standard specification for structural steel for marine boilers. A small sub-committee—consisting of representatives of the Admiralty, the Board of Trade, and the three registry societies—was appointed by the sub-committee on tests for steel and iron material used in the construction of ships and their machinery to draw up a draft specification for steel for marine boilers. The existing specificatons of the Admiralty, the Board of Trade, and the three leading registry societies were carefully compared, and from these a draft specification was prepared. This was adopted by the sub-committee on tests for steel and iron material on November 18, 1904, and was approved by the main committee on December 8 following. It is now published, together with an appendix giving forms for British standard tensile test pieces.

British Standard Tables of Pipe Flanges.—This report, issued by the Engineering Standards Committee, gives the results of the labours of the committee on pipe flanges. Twenty-four meetings have been held and a large amount of matter, collected from manufacturers and users of pipes of various classes, has been considered. Flanges are standardised in four classes, as follows: (1) Low pressure standard, for steam pressures up to 55 lb. and water pressures up to 200 lb. per square inch. (2) Intermediate pressure standard for steam pressures between 55 lb. and 125 lb. per square inch. (3) High pressure standard for steam pressures from 125 lb. to 225 lb. per square inch. (4) Extra high pressure standard for steam pressures between 225 lb. and 325 lb. per square inch. Particulars follow in regard to the general dimensions of flanges, number of bolts, sizes of bolt holes, diameters and thicknesses of flanges, etc. Tables are included showing the dimensions of the British standard pipe flanges, bends, etc., required in each of the classes specified. (Crosby Lockwood and Son, 7, Stationers' Hall Court, Ludgate Hill, E.C. 2s. 6d. net.)

Drivers' and Conductors' Diary and Record Book.—Mr. H. C. S. Osborne, a motor-man in the service of the Leicester Corporation Tramways, has compiled a useful little pocket-book for drivers and conductors on electric tramways. It is divided into two sections. In the first part the pages are ruled in columns for the entry of dates, car numbers, badge numbers, sections, number of hours worked, rate of wages, tickets sold, etc. If these particulars are correctly filled in each day, the motor-man or conductor will have a complete record of his work on the tramways—a record which is likely to prove extremely valuable should any dispute arise or report become necessary. The latter portion is printed as a diary and memorandum book, and this section will prove useful for making notes of any incidents in the day's routine to which future reference may become necessary. The book has been intelligently compiled, and it will be appreciated by the employee who takes an interest in his work. It will help him to be systematic, punctual, and exact in the performance of his duties; and these are the first steps on the ladder of promotion. (George Gibbons and Company, 49, King Street, Leicester. Sixpence.)

PATENT LIST.

Specially abstracted for "The Tramway and Railway World" from the Official Journal of Patents.

∴ If the inventions have been communicated the names of the communicators are given below in italics.

APPLICATIONS.

Applications for Letters Patent have been filed as follows:

4,066 Car seats—F. Bennett and S. A. Walker.
4,102 Improvements relating to electric conduit tramways—A. N. Connett.
4,164 Automatic signalling apparatus for tramways—A. E. Tanner and E. A. Claremont.
4,249 Improvements in electrical machinery, including their external circuits, with special reference to the regenerative system of electrical tramcar control—H. W. Dickinson.
4,283 Dry seats for tramcars—W. S. Ford and A. A. Parkinson.
4,431 Automatic signals for loop lines, signal arms and bells, the whole worked by electric tramcar automatically—G. W. Burden.
4,463 Motor vehicles for railways and tramways—G. G. Hooper.
4,529 Control of electro-motors on electric railway cars—F. Lydall.
4,701 Tramway rails, points and crossings—A. Brown and L. W. Crosta.
4,801 Life-guards for electric tramcars—M. B. Mountain, G. M. Gibson, and A. F. H. Head.
4,809 Single wheel braking gear and levers for tramcars—J. M. Grant.
4,827 Trolley poles for electric tramway vehicles—W. J. Bowden and J. W. Cronkshaw.
4,852 Signalling apparatus for use with electric railways or tramways—A. E. Barber.
4,855 Anchor appliances for tramway rails—J. Taylor and G. H. Archer.
4,879 Brake systems—British Thomson-Houston Company, Limited *(The General Electric Company)*.
4,880 Air brake systems and automatic valves therefor—The British Thomson-Houston Company, Limited *(The General Electric Company)*.
4,881 Electro-magnetic brakes—The British Thomson-Houson Company, Limited, and C. B. Larzelere.
4,882 Automatic air brakes—The British Thomson-Houston Company, Limited *(The General Electric Company)*.
5,010 Apparatus for operating the points of electric railways and tramways—E. Cross.
5,205 Trolleys for electric tramcars—J. W. Bradley and J. F. Mason.
5,229, 5,230, 5,231 Regenerative control of electrically propelled vehicles—J. S. Raworth.
5,273 Insulator for electric tramway street poles—E. Downward and J. P. Downward.
5,373 Apparatus for distributing sand beneath the wheels of tramway vehicles—S. Leach.
5,374 Trolley retrievers—W. L. Albee.
5,554 Insulators of the third rail of electric traction systems—F. G. Kleinsteuber.
5,662 Track construction and electric signalling equipment therefor—G. Thompson and H. W. Merchant.
5,665 Device for enabling the points of tramways to be actuated from the running car—C. Watler.
5,691 Automatic dry seat for tramcars—W. J. Carr.
5,863 Electric train signals—A. W. Sullivan and W. Renshaw.
5,893 Electrically propelled vehicles and permanent way therefor—A. St. V. Burnaby.
5,928 Rail joints—C. R. Robins, H. G. Lawrence, G. C. Dean, and A. E. Cady.
6,046 Rails for tramways—G. Winterburn.
6,152 Drill cramps for drilling the flanges of tramway rails *in situ*—H. Booth.
6,195 Trolley stands—B. A Grasberger.

SPECIFICATIONS ACCEPTED.

The following applications, of which the specifications have been published, are now open to opposition by prior patentees or any other persons interested:

1904.

3,072 Cut-outs for overhead electrical conductors—Nash and Eachus.
6,588 Tramcar step treads—Hudson.
8,145 Adjustable and removable top or cover for tramcars—Field.
15,513 Apparatus for cleaning tram lines—Sexton and Sexton.
16,844 Tramway rail clip—Bidder and Railway and General Engineering Company, Limited.
8,096 Device for catching and supporting overhead electric wires when fractured—Denton-Ingham and Jones.
9,427 Automatic electro-magnet sanding gear for use on electric railways and tramways operated instantaneously with the electric brake from the controller handle—Crosbie and Ward.
10,356 Construction of mounting of trolley arms for collecting electric energy from overhead cables for electric traction—Phillips and Parkin.
24,444 Tramway vehicles—Gibbs.
27,691 Car steps—Tozer.
29,001 Electric railway conduit systems—Van Aerschot.
5,978 Covers for the outside of tramcars—Findlay.
8,077 Trolley heads of electric tramcars—Thompson.
9,565 Electric tramway vehicles—Raworth.
17,939 Electric trolleys—Lauvernier.
24,675 Electric brakes for trams—Ransford *(American Electric Brake Company)*.
5,005 and 5,006 Destination indicators—Baylor.
7,164 Seat frames for tramcars—Morgan.
7,428 Apparatus for moving electrically the points on electric tramways and railways.—Tierney and Malone.
9,540 Tramway points—E. Allen and Company, Limited, and Robinson.
9,657 Brakes for tramcars—Fidler.
9,985 Railway crossings especially applicable at the intersection of tramway lines with those of small railways—Hettstedt.
12,530 Means for connecting railway and tramway rails—Ambert.

1905.

52 Station indicators for cars—Ornstein and Dorff.

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TRAMWAYS, RAILWAYS, & MINES,

Supplied Loose or . . . Accurately Fitted on Axles.

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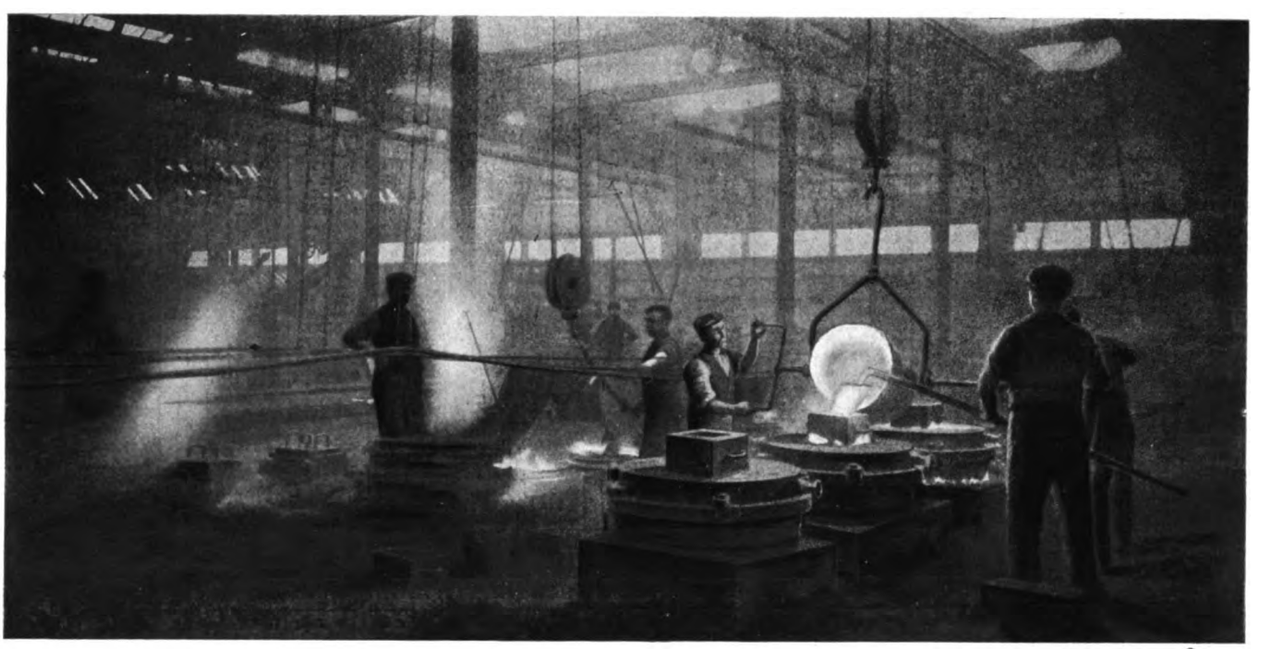

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TRAFFIC RETURNS.

TRAMWAY COMPANIES.

	1904. WEEKS ENDING					1905. WEEKS ENDING					AGGREGATE.		
	Feb. 27.	Mar. 5.	Mar. 12.	Mar. 19.	Mar. 26.	Feb. 25.	Mar. 4.	Mar. 11.	Mar. 18.	Mar. 25.	Wks.	1905.	Increase or Dec.
	£	£	£	£	£	£	£	£	£	£		£	£
Aberdeen Corporation	1,066	1,103	1,065	1,081	1,127	1,045	1,080	1,052	1,075	1,093	43	57,890	+ 5,684
Airdrie	192	197	181	186	186	183	185	200	193	194	12	2,320	+ 3
Barcelona	1,542	1,555	1,606	1,825	1,751	1,825	2,010	2,113	2,001	2,118	12	23,593	+ 4,375
Barnsley	163	148	146	157	158	152	162	153	157	162	12	1,804	+ 58
Barrow	140	139	135	121	132	176	194	199	199	212	12	2,195	+ 375
Bath	528	478	507	588	548	531	506	528	551	657	12	6,507	+ 583
Birmingham, City of	4,997	4,686	4,994	5,135	5,105	5,256	5,449	5,517	5,591	5,993	12	63,659	+ 3,766
Birmingham and Midland	824	794	809	839	831	1,130	1,153	1,181	1,171	1,246	12	13,323	+ 3,371
Blackpool and Fleetwood	163	200	213	181	209	177	216	179	197	237	12	2,274	— 59
Blackpool Corporation	283	269	270	286	312	309	299	316	333	454	51	47,317	+ 6,372
Blackpool, St. Anne's, and Lytham ...	139	140	153	152	177	139	136	149	152	202	20	2,791	— 59
Bolton Corporation	1,547	1,531	1,705	1,614	1,617	1,566	1,674	1,679	1,815	1,774	52	93,772	+ 956
Bournemouth Corporation	835	784	905	874	907	849	876	940	964	1,051	50½	53,968	+ 2,530
Bradford Corporation	3,360	3,287	3,355	3,510	3,620	3,553	3,720	3,764	3,975	3,939	51	222,449	+ 31,363
Bristol	4,357	4,199	4,344	4,608	4,467	4,263	4,485	4,486	4,427	4,783	12	53,725	+ 656
Burnley Corporation	862	881	873	885	880	885	942	946	1,023	1,052	12	11,829	+ 1,633
Burton-on-Trent Corporation ...	275	274	281	286	284	274	296	306	312	303	51½	17,213	—
Calcutta	Rs. 36,178	35,855	36,166	35,414	35,213	39,364	43,574	42,720	38,997	38,058	11	450,643	+ 51,334
Carlisle, City of	165	157	155	161	169	129	137	140	136	148	12	1,714	— 284
Chatham and District	475	443	490	496	489	564	548	596	600	655	12	6,826	+ 900
Cork	367	355	348	414	377	375	389	420	406	454	12	4,816	+ 205
Devonport	423	425	448	446	437	394	407	413	412	466	12	5,072	— 180
Dover Corporation	154	150	164	165	168	157	163	169	169	178	52	11,044	— 101
Dublin and Lucan	87	81	95	94	99	91	89	92	108	102	12	1,132	+ 32
Dublin United	4,145	4,071	4,099	4,430	4,289	4,184	4,316	4,377	4,738	4,533	12	52,464	+ 980
Dudley—Stourbridge	760	685	727	740	757	742	747	799	789	853	12	8,856	+ 333
Dundee City	760	778	750	765	762	777	779	790	774	794	40	36,745	+ 391
East Ham U.D.C.	598	557	609	624	610	628	630	653	731	771	51	36,059	+ 2,199
Edinburgh and District	3,898	3,866	3,956	4,144	4,022	4,127	4,359	4,287	4,527	4,564	12	53,064	+ 4,678
Gateshead	833	807	836	837	858	878	869	888	882	897	12	10,283	+ 344
Glasgow Corporation	12,997	12,907	12,988	13,322	13,571	13,536	14,084	13,907	14,544	14,792	43	610,915	+ 31,677
Gravesend and Northfleet	204	199	216	215	217	185	184	196	198	210	12	2,222	— 211
Greenock—Port Glasgow	415	479	418	461	431	463	578	494	571	532	12	6,132	+ 798
Harrow Road and Paddington ...	229	212	230	252	257	219	211	224	226	263	12	2,670	— 77
Hartlepool	236	224	230	249	248	247	238	257	243	259	12	2,861	+ 34
Hull Corporation	1,895	1,955	1,969	2,021	1,990	1,990	2,090	2,139	2,218	2,089	51	111,190	+ 11,672
Ilford Corporation	337	375	362	322	365	346	345	363	388	437	51½	22,381	+ 1,161
Ilkeston Corporation	120	117	127	138	132	102	105	109	125	116	52	6,752	— —
Kidderminster	92	92	99	97	98	87	89	92	92	104	12	1,077	— 20
Lanarkshire	553	558	521	563	580	595	620	661	608	659	12	7,542	+ 689
Leeds Corporation	4,763	4,628	4,799	4,999	5,087	5,238	5,308	5,456	5,368	5,652	52	295,278	+ 18,052
Liverpool Corporation	9,208	9,001	9,317	9,533	...	9,887	9,828	9,851	10,075	...	11	107,800	+ 4,483
London County Council	9,780	9,189	10,130	10,644	...	12,091	12,230	12,553	12,813	...	51½	638,045	+ 141,911
London General Omnibus	20,339	18,937	21,645	22,247	22,048	20,349	20,992	21,506	21,985	24,683	11	233,859	+ 5,720
London Road Car	6,897	6,357	7,325	7,415	7,408	6,930	7,167	7,340	7,456	8,396	12	86,882	+ 2,421
Manchester Corporation	10,575	10,422	10,634	10,754	10,913	10,959	11,356	11,662	11,877	12,515	51	618,295	+ 31,638
Merthyr	188	180	184	193	189	174	176	185	187	199	12	2,068	— 111
Metropolitan	1,105	1,007	1,186	1,172	1,138	1,840	1,796	1,852	1,863	2,350	12	22,747	+ 9,935
Middleton	236	227	237	254	255	252	250	263	262	337	12	3,124	+ 318
Newcastle-upon-Tyne Corporation ...	3,326	3,400	3,529	3,447	3,457	3,552	3,517	3,548	3,549	3,577	12	42,457	+ 980
North Metropolitan	10,271	9,731	10,682	10,882	10,856	10,159	10,245	10,628	10,857	11,910	12	127,522	— 715
Oldham—Ashton	478	458	468	494	487	474	480	500	500	552	12	5,790	+ 154
Oldham Corporation	1,023	993	1,063	1,042	...	1,318	1,350	1,378	1,533	964	52	65,553	+ 6,298
Peterborough	105	99	110	111	114	98	99	104	107	123	12	1,210	— 58
Poole	221	210	242	265	224	205	222	225	234	269	12	2,600	— 31
Potteries	1,566	1,555	1,627	1,661	1,686	1,628	1,579	1,682	1,678	1,649	12	19,215	+ 413
Rossendale Valley	161	153	159	164	163	171	176	173	177	185	12	2,125	+ 213
Rothesay	42	39	40	46	50	39	51	45	44	48	12	528	+ 35
Salford Corporation	3,511	3,453	3,640	3,669	3,687	3,599	3,779	3,871	4,100	3,916	51	207,289	+ 10,486
Sheerness	43	42	46	44	45	58	52	60	61	61	12	642	+ 124
Sheffield Corporation	4,091	3,938	4,447	4,325	4,365	4,297	4,442	4,536	4,740	4,568	52	240,565	+ 8,214
Southampton Corporation	820	793	785	816	837	763	761	775	828	875	51	48,268	— 2,626
Southport	216	227	223	228	237	215	255	224	240	262	12	2,709	— 15
South Staffordshire	679	630	691	731	688	632	649	662	679	719	12	7,671	— 402
Sunderland Corporation	...	1,016	1,122	1,064	...	...	1,105	1,117	1,144	...	50	62,425	+ 1,676
Swansea	447	417	481	425	450	485	463	476	557	499	12	5,482	+ 225
Taunton	42	42	49	41	42	36	40	44	45	43	12	474	— 55
Tynemouth	193	188	192	211	206	162	169	173	182	195	12	2,026	— 321
Tyneside Tramways and Tramroads	277	269	276	304	300	337	338	351	349	386	12	3,897	+ 589
Wallasey U.D. Council	550	551	571	575	598	601	658	635	659	706	51	37,460	+ 2,746
West Ham Corporation	...	...	...	...	...	1,049	1,063	1,098	1,080	1,264	...	...	—
Weston-super-Mare	24	21	22	29	28	28	25	28	29	40	12	325	+ 53
Wolverhampton Corporation ...	353	354	508	507	464	639	725	696	722	708	52	36,807	— —
Wolverhampton District	332	304	323	346	357	355	330	352	352	371	12	4,053	+ 194
Worcester	250	214	227	234	230	239	245	255	277	295	12	3,005	+ 800
Wrexham and District	96	102	92	94	97	94	97	104	91	103	12	1,108	— 19
Yorkshire (Woollen) District ...	514	460	480	529	564	544	540	582	559	674	12	6,623	+ 775

RAILWAY COMPANIES.

	1904. WEEKS ENDING					1905. WEEKS ENDING					AGGREGATE.		
	Feb. 27.	Mar. 5.	Mar. 12.	Mar. 19.	Mar. 26.	Feb. 25.	Mar. 4.	Mar. 11.	Mar. 18.	Mar. 25.	Wks.	1905	Increase or Dec.
	£	£	£	£	£	£	£	£	£	£		£	£
Brecon and Merthyr	1,887	1,719	1,974	1,989	1,750	2,036	1,949	2,007	1,529	1,680	12	23,587	+ 1,318
Cambrian	5,049	5,740	5,148	5,181	5,857	5,069	5,685	5,178	5,146	5,732	12	60,450	— 1,395
Central London	7,138	7,248	7,119	7,062	7,280	7,248	7,224	7,195	7,070	7,025	12	86,153	+ 918
City and South London	3,127	3,285	3,101	2,973	3,156	2,998	2,964	3,005	2,884	2,833	13	38,901	— 2,508
Furness	8,118	8,329	8,496	8,993	8,456	8,265	8,494	8,736	9,013	8,829	12	98,971	+ 1,719
Great Central	59,938	60,897	60,638	61,997	65,944	65,338	63,716	63,257	63,540	67,315	12	774,030	+ 40,395
Great Eastern	93,200	94,800	94,000	92,700	94,600	91,700	93,500	93,100	90,800	91,900	12	1,092,900	— 20,000
Great Northern	106,129	104,514	108,742	109,371	110,128	101,000	105,800	101,100	104,500	104,800	12	1,221,900	— 42,935
Great Western	205,400	206,400	213,000	217,500	214,100	205,900	209,900	207,100	205,900	208,800	12	2,470,800	+ 4,900
Hull and Barnsley	7,769	8,058	8,539	8,076	8,030	8,317	8,370	8,882	8,584	8,890	12	108,176	+ 6,856
Isle of Wight	496	490	471	520	529	487	494	422	483	597	12	5,872	+ 331
Ditto Central	605	648	598	613	593	540	582	570	596	678	12	7,162	+ 222
Lancashire and Yorkshire	93,488	93,096	95,317	95,091	97,936	96,603	96,527	98,464	97,382	101,111	12	1,152,118	+ 25,145
Liverpool Overhead	1,477	1,449	1,535	1,512	1,600	1,409	1,420	1,469	1,497	1,528	12	19,096	— 691
London, Brighton, and South Coast	51,901	54,639	52,030	54,129	54,069	49,748	57,193	50,214	51,258	53,797	12	640,863	+ 2,935
London and North-Western ..	255,000	257,000	254,000	258,000	265,000	252,000	260,000	248,000	252,000	257,000	12	2,978,000	— 54,000
London and South-Western ...	76,100	72,400	78,200	78,100	77,700	76,500	78,000	78,900	79,600	78,400	12	923,900	+ 22,300
London, Tilbury, and Southend ...	7,113	7,044	7,728	7,356	7,636	7,092	7,241	7,751	7,429	7,852	12	89,559	+ 2,525
Maryport and Carlisle	2,073	2,022	1,995	2,079	1,937	2,202	2,177	2,002	2,088	1,954	12	25,042	+ 1,408
Mersey	1,415	1,447	1,502	1,450	1,479	1,558	1,560	1,516	1,620	1,516	12	19,079	+ 1,295
Metropolitan	16,659	16,634	16,909	16,738	16,902	16,763	16,877	17,128	17,043	17,221	12	204,224	+ 1,494
Ditto District	7,738	7,720	7,706	7,638	7,741	7,749	7,787	7,718	7,659	7,355	12	91,889	— 2,875
Midland	212,624	214,380	208,522	209,215	213,268	211,280	216,177	206,082	208,075	206,877	12	2,506,804	+ 10,490
North-Eastern	165,522	165,766	168,014	170,687	173,730	164,836	165,134	166,893	164,315	169,262	12	1,904,917	— 32,746
North London	8,150	9,690	9,426	9,877	9,421	8,668	9,035	8,790	8,985	8,893	12	108,833	— 8,825
North Staffordshire...	16,920	17,095	17,721	17,635	17,929	17,196	16,888	17,358	16,746	17,268	12	201,214	— 6,818
South-Eastern and Chatham ...	71,012	80,139	73,853	74,857	76,709	70,717	83,904	75,043	73,903	76,752	12	906,674	— 2,693
Taff Vale and Penarth	19,497	18,383	18,123	19,141	19,968	18,269	18,232	16,530	17,568	19,253	12	218,457	— 7,449
Caledonian	77,570	78,500	79,037	80,392	80,521	78,144	80,567	78,009	79,298	80,298	8	628,070	+ 6,321
Glasgow and South-Western ...	30,473	30,739	30,450	30,542	31,095	30,518	30,796	30,134	29,988	30,460	8	239,825	— 1,051
Glasgow District Subway	1,411	1,451	1,387	1,399	1,399	1,386	1,404	1,389	1,382	1,356	8	10,613	— 154
Great North of Scotland	7,800	8,421	8,459	8,638	8,789	7,996	8,175	8,186	7,868	8,420	8	64,126	— 1,249
Highland	8,212	8,701	8,562	8,977	8,218	8,388	8,342	8,033	8,232	8,141	8	65,557	— 2,433
North British	80,411	82,896	81,969	84,216	82,841	81,514	88,666	81,019	82,343	82,063	8	654,768	+ 6,073
Belfast and County Down	2,337	2,165	2,796	2,313	2,166	2,479	2,228	2,750	2,243	2,209	12	27,409	— 433
Cork and Bandon	1,390	1,431	1,530	1,564	1,320	1,684	1,488	1,549	1,309	1,600	12	16,703	— 595
Dublin, Wicklow, and Wexford ...	4,589	4,482	4,166	3,852	4,588	4,766	4,812	4,086	4,159	4,758	12	54,913	+ 3,601
Great Northern of Ireland	16,297	16,553	17,054	17,269	16,998	16,448	16,301	17,143	17,322	16,326	12	190,206	— 2,382
Great Southern and Western ...	20,463	24,841	22,906	23,471	24,166	21,010	23,100	22,825	21,872	22,095	12	258,835	— 8,502
Midland Great Western	10,841	9,249	9,952	10,291	9,943	10,474	10,867	9,801	9,824	10,969	12	117,080	— 3,972

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THE Tramway & Railway World
A REVIEW OF CURRENT PROGRESS IN ELECTRIC AND OTHER TRACTION

VOL. XVII. LONDON, MAY 4, 1905. VOL. XVII.

THE LIGHT RAILWAYS OF WALTHAMSTOW.

The system of light railways just completed by the Walthamstow Urban District Council is undoubtedly of very great importance, for not only will it give all the facilities of a local tramway, but it will in all probability eventually form part of a most comprehensive scheme for linking up the densely populated districts on the eastern side of London with those to the north of the Metropolis. The terms of the Walthamstow and District Light Railway Order, 1903, the authority under which the tramways have been constructed, provide for inter-running with Leyton on the east and Tottenham on the north. Direct communication with both Chingford and Woodford is also provided. Although the work in connection with the tramways did not actually commence until March, 1904, as far back as 1898 the matter was under consideration. On September 23 of that year the Town Clerk of Walthamstow was instructed to take the necessary steps to obtain a Provisional Order for the construction of electric tramways. A month later, however, it was decided that the matter should stand over for the time being. In the following year the matter was again considered, and on December 19, 1899, the seal of the Council was affixed to a memorial to the Board of Trade. In the following March Major Hutchinson reported upon the scheme, and in consequence of his objections the consulting engineer was asked to revise his plans. On October 16, 1900, the revised plans were approved by the Council, and it was decided to apply for a Provisional Order. At a subsequent

Fig. 4.—Special Track and Overhead Work at Bell Corner, Walthamstow.

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meeting of the Council, however, it was decided to take the whole body of ratepayers into confidence, and the Clerk was instructed to call a public meeting of ratepayers to consider the question of the proposed establishment of tramways for Walthamstow.

Nothing appears to have been done, however, until May, 1901, when the hands of the Council were forced to some extent by the Metropolitan Omnibus Company depositing plans for the Tottenham and Epping Forest Light Railway. This scheme would, if sanctioned, have seriously injured the prospects of a local undertaking. Immediate action was then taken, and on June 3 the Town Clerk, in conjunction with Mr. G. W. Holmes, A.M.I.C.E., the resident engineer, were directed to submit a report showing the advantages and comparative cost of a light railway and a tramway scheme respectively. This report was presented on July 10, when Mr. Holmes was directed to prepare a scheme of light railways for Walthamstow and district. This scheme was approved, and on October 9 Mr. Holmes was instructed to prepare Parliamentary plans for the Light Railway Order, construction of permanent way, etc. These were subsequently approved and sent to the Light Railway Commissioners in time for the November notices.

On October 31 of the same year an enquiry was held at Tottenham in reference to the Company's scheme for the Tottenham and Epping Forest Light Railway. The Walthamstow Council opposed, and placed Mr. Holmes' plans before the Commissioners, with the result that the consideration of the Company's lines through Walthamstow was postponed until the Walthamstow Council's scheme came before the Commissioners. An enquiry was held in reference to the Council's scheme at Walthamstow on January 31, 1902, and adjourned until March 20, when the Commissioners provisionally sanctioned the scheme. The complete Order was obtained in February, 1903.

Tenders were invited for the whole of the work of construction in December, 1903, and in January, 1904, W. T. Henley's Telegraph Works Company were awarded the contract for the permanent way, cables, and overhead equipment. On March 17 the first wedge was driven. At the invitation of the contractors this was done with some little ceremony by Mr. Caleb Day, the then Chairman of the Council and also of the Tramway Committee, the Town Clerk, Mr. C. Sydney Watson, holding the wedge in position.

As will be seen by the accompanying map, Walthamstow is situated to the north east of London, and is one of the largest of the suburban districts. It has a population of about 116,000, and an area of 4,355 acres, about one third of which has still to be developed.

The lines authorised by the Light Railway Commissioners are of a total length of about 11 miles single track, about six furlongs being in the Chingford district and about three furlongs in the Leyton district. In the original application to the Light Railway Commissioners powers were asked to construct a line about a quarter of a mile in length in the parish of Woodford. In consequence of the opposition of the Woodford District Council this was eliminated. In regard to the railways in the Tottenham district—about one mile in length, also included in the application—a satisfactory agreement was arrived at between the Council and the North Metropolitan Tramways Company, which provides for mutual running powers. Under this agreement the Walthamstow District Council have power to run over the Tottenham piece of line which the Company were to construct, and the Company have power to run over that portion of the Walthamstow system leading to Woodford *via* Forest Road. By this arrangement an excellent service of through cars will eventually be maintained from Woodford New Road, *via* Forest Road and Ferry Lane, to High Street, Tottenham, a distance of about four miles. For some reason or other the Tottenham line has not yet been constructed, so that for the time being the Walthamstow line ends in Ferry Lane at the bridge which crosses the river Lea. The Woodford and Tottenham line, which commences in Woodford New Road at the junction of the said road with Oakhill Road, passes into Forest Road at a point about four furlongs from the commencement. From this point a line about three furlongs in length continues along Woodford New Road, and forms a junction with the existing tramways of the Lea Bridge, Leyton, and Walthamstow Tramway Company at their terminus. The Lea Bridge, Leyton, and Walthamstow Tramway is a horse line, the greater portion of which is in the district of Leyton. At the time the District Council of Walthamstow applied for their Order an agreement was entered into between the Leyton and Walthamstow Councils, by which each were to purchase and reconstruct that portion of the Lea Bridge Company's line which ran through their respective district. When the time arrived, however, for the Walthamstow Council to give formal notice to treat for the purchase of the section in their district it was found impossible —for reasons best known to themselves—to get the necessary two-thirds majority, so the matter fell through. For the time being the position was a most interesting one, for on the one hand there was a distinct breach of agreement with the Leyton Council, as they had withheld their opposition to the Walthamstow scheme by reason of this agreement, while on the other hand the Walthamstow Council appeared to have spoiled one of the most promising sections of their scheme. After considerable discussion, however, a new agreement was made, by which the Walthamstow Council gave the Leyton Council power to purchase the lines of the Lea Bridge Company in the Walthamstow district, so that

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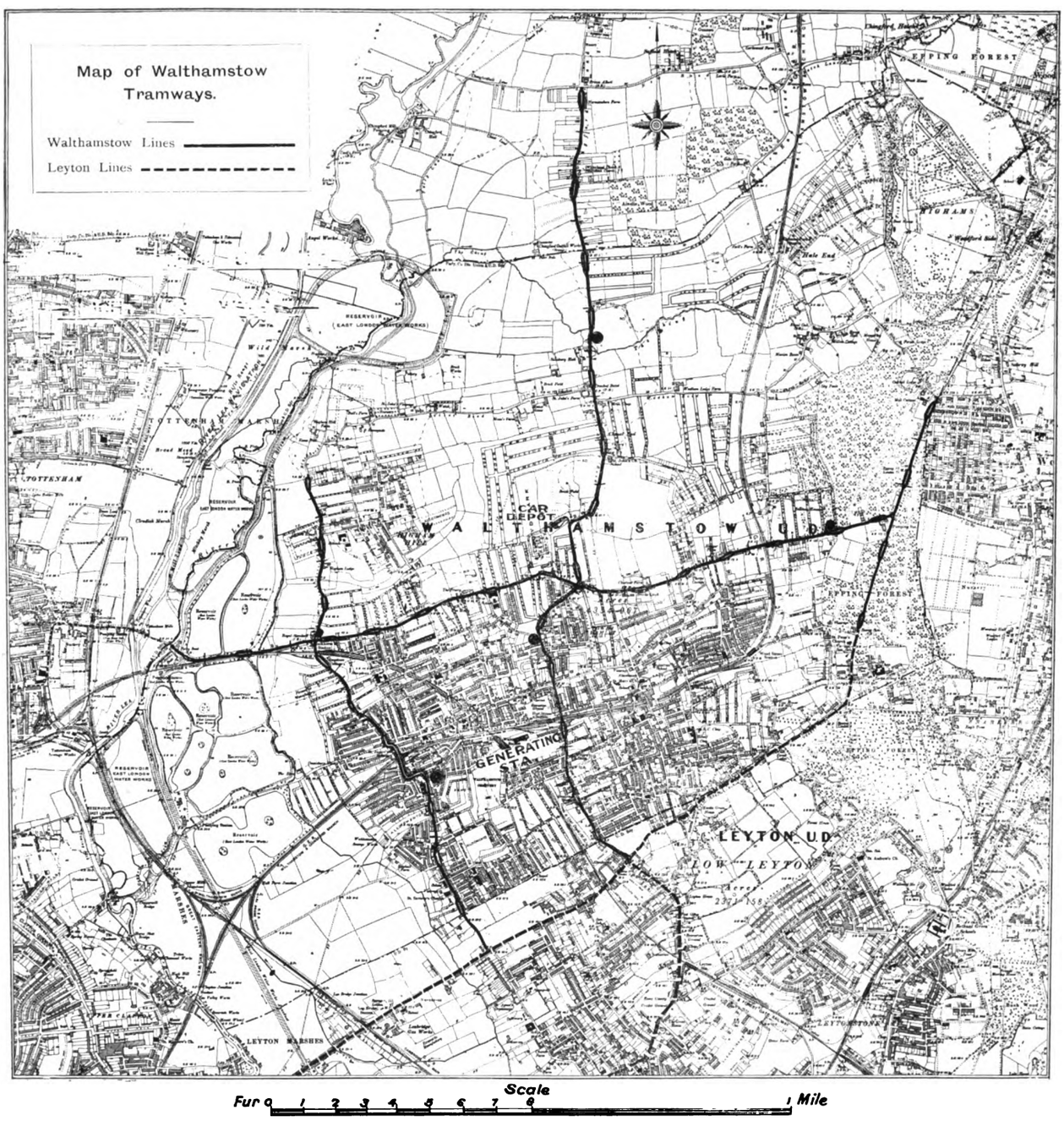
when the Leyton system is complete, direct communication between Woodford and Leyton will be established.

The third line forming part of the Walthamstow system runs from Lea Bridge Road, Leyton, through Hoe Street to Forest Road, and thence along the Chingford Road to a point about three-quarters of a mile within the parish of Chingford. This line commences in the Leyton district at a point 13·5 chains south of the boundary between the districts of Leyton and Walthamstow, crossing the Lea Bridge Road and forming a junction with the existing tramways in High Street, Leyton. Junctions have also been made with the existing tramways in Lea Bridge Road. Both these tramways are at present horse systems, but will shortly be electrified by the Leyton District Council, the purchase of which, as before stated, forming part of their tramway scheme. As will be seen, this line will afford means of direct communication between the districts of Leyton and Chingford. The fourth line commences in Leyton at a point where Markhouse Road intersects Lea Bridge Road. A junction is again made with the existing tramway in Lea Bridge Road, and proceeding for a distance of 1 furlong, 4·61 chains, the line reaches the Walthamstow boundary in Markhouse Road. Passing along Markhouse Road, St. James Street, Blackhorse Road and Blackhorse Lane, this line joins the Forest Road and Tottenham line at the Bell Corner. It will be noticed that this railway brings Leyton in direct communication with Tottenham.



Owing to the fact that Walthamstow is made up of a collection of villages and one-time

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country lanes, a considerable amount of road widening was necessary before any part of the system could be completed; some idea of the work in this direction will be gathered from the following list of alterations to bridges in the district authorised by the Light Railway Order. (1) Widening the bridge carrying Forest Road over the Dagenham Brook, so that the same should have a uniform width of 40 feet between the parapets. The width of the bridge was 31 feet. (2) Widening the bridge carrying Forest Road over the Great Eastern Railway to a uniform width of 40 feet; previous width 25 feet. (3) Widening the bridge carrying Blackhorse Lane over Higham Hill Brook to 40 feet; previous width 30 feet. (4) Constructing a new iron girder bridge over the River Lea in place of the one previously carrying Forest Road over that river. (5) Constructing a new iron girder bridge over the Coppermill stream in place of the bridge carrying Forest Road over that stream. (6) Constructing a new bridge over the River Ching in place of the one carrying the Chingford Road over the said river.

Each of the new bridges has a uniform width of 40 ft. between the parapets, the footpaths, kerbs, or other necessary work upon new bridges or widenings being made up at the expense of the Council, and dedicated to the public as a highway. From the foregoing it will be seen that the work of Mr. G. W. Holmes was exceedingly heavy, as the whole of the plans and specifications were prepared by him, the work being afterwards carried out under his supervision, with the very able assistance of Mr. J. Neave, the assistant engineer.

An important item in connection with these widenings was the settlement of the purchase price for the lands taken under the Order. As is usual in such cases several of the owners asked inflated prices in the first instance; it is therefore satisfactory to know that Mr. Holmes in conjunction with Mr. C. Sidney Watson, L.L.B., the Town Clerk, was able in every case to effect a settlement to the satisfaction of the Council without incurring the expense and delay of an appeal to arbitration. Mr. Watson was also successful in obtaining a loan for £180,000, the amount sanctioned by the Order, on most reasonable terms.

With the exception of a short section in St. James Street the whole of the system is of single track, 4 ft. 8½ in. gauge, with passing places averaging from four to five to the mile. In St. James Street it was decided to have a double line, provision for which was not made in the original Order. It was found necessary to lower the road to permit the double-decked cars to pass under the Great Eastern Railway Company's bridge at St. James Street Station with a wider margin of safety. The overhead system of electric traction was decided upon, additional plant being installed for the purpose at the Council's electricity station, where a very considerable plant was already working in connection with the electric lighting of the town. Mr. J. Enright, A.M.I.E.E., who has acted as consulting engineer to the Council for the lighting installation, was also retained for the electrical portion of the light railway undertaking.

The system as a whole may be regarded as a fairly level one; the steepest gradients occur on the section in Forest Road, from Wood Street to the point where Forest Road joins Woodford New Road. Here for a short distance there is a gradient of 1 in 20. The sharpest curves on the system have radii of 40 ft. Messrs. Dick, Kerr and Company, as sub-contractors to Messrs. Henley, were responsible for the whole of the permanent way and the overhead equipment.

THE TRACK.

The concrete for the roadbed is composed of one part of Portland cement to six parts of clean Thames ballast; this is laid to a uniform depth of 6 in. between the rails and 18 in. beyond the outside of the rails of both single and double track. Under each rail joint, however, a pocket 3 ft. in length, 18 in. in width, and 18 in. in depth, was excavated. These pockets, after being well rammed, were filled to a depth of 6 in. with concrete as a bed for the "Cooper" patent rail joints which are used throughout the system.

The rails, which were supplied by the North Eastern Steel Company of Middlesbrough, weigh 100 lb. to the yard, in 45 ft. lengths for the straight track, and 106 lb. per yard in 30 ft. lengths for curved track. The depth is 6½ in. over all, width of head 3 11/16 in., width of flange 7 in., width of groove 1⅛ in., and width of tread 2 in. The width of groove in rails on curves of less than 66 ft. radius is 1¼ in. The chemical composition of the steel of which the rails were rolled is as follows: Carbon, 0·40 to 0·55 per cent.; manganese, 0·70 to 1 per cent.; silicon, ·1 per cent.; phosphorus, ·08 per cent.; sulphur, ·08 per cent. The holes for fish bolts are 1 in. in diameter, and those for rail bonds ¾ in. The slots for tie bars are 3 in. long by 1 in. wide, with half round ends.

The fish plates were also supplied by the North Eastern Steel Company, and were made from steel in all respects similar to that from which the rails were manufactured. They are 24 in. long and weigh 49 lb. per pair, and six holes are punched in each. The No. 1 pattern of Cooper's patent anchor rail joint plate is used; these are 24 in. long, and both in section and quality are generally similar to the rails. Each joint plate is 63 lb. in weight, and is riveted to the flanges of the abutting rails by means of 12 rivets ⅞ in. in diameter. Intermediate holding down plates of the anchor type are also used on all curves; these plates are 16 in. long, and are attached to the rails in a similar manner to the joint plates. The tie bars were supplied by Messrs. Bayliss, Jones, and Bayliss, and are of their well-known patent rolled weldless

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type fitted with "Eureka" locknuts. They are placed at every 5 ft. of track length. The bolts for the fish plates were also supplied by Bayliss, Jones, and Bayliss; they are of the best mild steel and 1 in. in diameter, and also fitted with the Bayliss patent "Eureka" locknut.

without any delay. The nature of the most complicated special work is indicated in Fig. 4, which shows the track work and overhead wiring at the chief junction, that of Forest Road and Chingford Road, and in Fig. 9, which is a plan of the depôt.

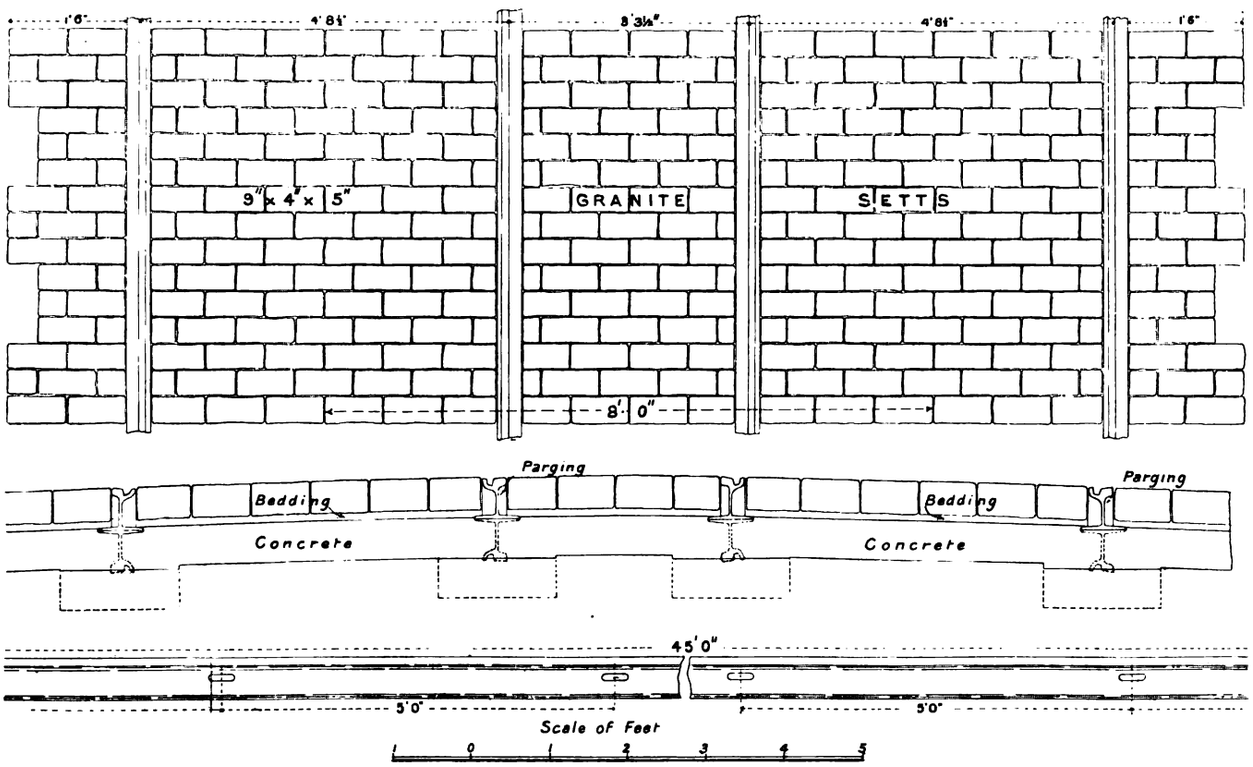

Fig. 1.—Plan and Section of Track and Elevation of Rail.

Drawings of the track and joint are given in Figs. 1, 2, and 3.

The whole of the special work, points, crossings, etc., was supplied by Messrs. Edgar Allen and Company, Sheffield. The points are made of toughened cast steel, with manganese steel tongues in the movable and automatic points, and manganese steel centres in the opens or mates. The

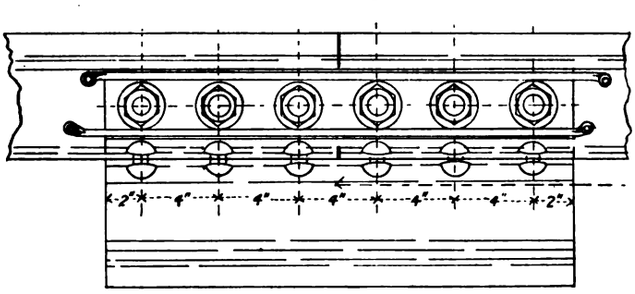

Fig. 2.—Elevation of Rail Joint.

crossings are of cast steel with manganese centres. The movable points are fitted with specially-long tongues, and while equal in action to longer points, are very much cheaper. Compound points and crossings had to be made for the track work at the depôt, and special patterns were also required for the work at the spot known as Bell Corner. The whole of the special work was set out at Messrs. Allen's foundry before being forwarded, and was consequently laid in final position

The paving of the track is chiefly of granite pitching. Jarrah wood (supplied by Millar's Jarrah and Karri Forests, Limited), however, is used on a short section in Hoe Street, and also in St. James' Street, and in front of public buildings. Where wood is used the whole surface of the road is paved, the concrete being finished off with a floating of fine concrete ¾ in. thick. The other portions of the system are paved within the rails and to the extent of 18 in. on each side of the track with granite sets in regular parallel courses bedded on 1 in. of clean bedding, consisting of three parts of sharp sand to one part of Portland cement. The joints of the paving are filled with small granite chippings, and grouted with bitumen. Each side of the rail web is filled in with a parging consisting of three parts dry sand to one part cement. In Walthamstow, the outer edge of the granite

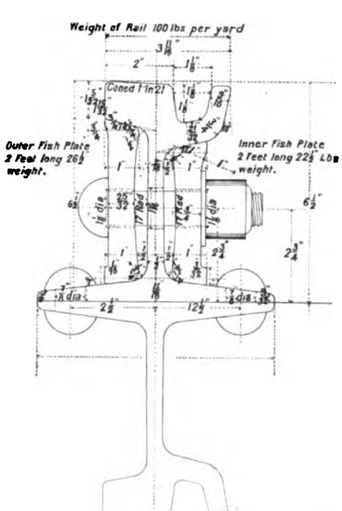

Fig. 3.—Section of Rail Joint.

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margin is toothed at every third course. In Leyton and Chingford districts the outside edge has a straight run. The teething of the outer edge of the margins can clearly be seen in the illustrations, and it is in view of the number of accidents that occur from time to time owing to the skidding of vehicles upon the straight run of granite margins that induced Mr. Holmes to adopt this form of margin. For the wood paving, well-seasoned Jarrah blocks of a uniform size were used; these are 9 in. long, 3 in. wide, and 4 in. deep, each block being dipped in a hot pitch mixture for about half of its length and quickly stuck down to its foundation. The whole surface of the paving was afterwards grouted with hot pitch forced into the joints with squeeges, and dressed with a coating of crushed shingle.

Neptune rail bonds are used throughout, the section being of 6/0 S.W.G. The fish plate is spanned by two bonds, each 25 in. long; the rails of the single track are cross bonded at intervals of about 40 yds. with a bond about 66 in. long, and at passing places the two inner rails are connected by a similar bond about 48 in. long. Points and crossings are bonded by one bond to each rail adjacent to them. The lengths of the bonds where the rails are separated by points and crossings are 114 in. and 60 in. respectively.

FEEDER CABLES.

The cables are paper insulated and lead covered, and were manufactured and laid by W. T. Henley's Telegraph Works Company, Limited. The positive and negative feeders are single cables, and the pilot and telephone cables are made up as multicore. All cables are laid solid in earthenware troughing with hard tile covers. All joints are made in cast-iron boxes, and disconnecting boxes are placed at every half mile for testing purposes.

The positive feeders are connected at the feeder pillars by means of rubber cables connected to the paper cables in cast-iron joint boxes, and drawn into cast-iron pipes to the feeder pillars. The negative feeders are connected at the feeder pillars in the same way as the positive feeders, and from there are bonded to the rails. The pilot and telephone cables are run out to the end of the different sections, the pilot being bonded on to the rails, and the telephone cables connected to the telephones in the feeder pillars.

The negative feeders run to feeder pillars about two-thirds of the way between the positive feeder pillars and the generating station.

The sizes, lengths, and feeding points of feeders are as follows:

Pos. feeder A. ·65 section, 3,400 yds., to Forest Road.
Neg. ,, A, ·7 ,, 2,300 ,, corner of Shernall Street and Forest Road.
Pos. ,, B, ·65 ,, 2,200 ,, Blackhorse Bridge on Forest Road.
This feeder is tapped for connection to the overhead trolley wire at the corner of St. James Street and South Grove.
Neg. feeder B, ·7 section, 1,320 yds., to Blackhorse Road.
Pos. ,, C, ·5 ,, 3,400 ,, Chingford Road.
This feeder is tapped for connection to the overhead trolley wire at the corner of Chingford Road and Forest Road.
Neg. feeder C, ·55 section, 1,800 yds., along Chingford Road.
Pos. ,, D, ·4 ,, 1,050 ,, Hoe Street corner of Greenleaf St.

OVERHEAD EQUIPMENT.

The overhead equipment as carried out by Messrs. Dick, Kerr, and Company, in conjunction with the permanent way, is an exceptionally fine piece of work. The greater portion of the system is of the side bracket form of construction, span wire being used, however, on certain sections of the route. The poles are of mild steel 31 ft. long, and in three sections. The sections lap one another for a distance of 18 in., and are shrunk together without liners. Three sizes of poles are used as follows:

A. Base section, 17 ft. high, 7 in. internal diameter, $\frac{3}{8}$ in. thick. Middle section, 9 ft. 6 in. high, 6 in. internal diameter, $\frac{1}{4}$ in. thick. Top section, 7 ft. 6 in. high, 5 in. internal diameter, $\frac{1}{4}$ in. thick.

B. Base section, 17 ft. high, 8 in. internal diameter, $\frac{3}{8}$ in. thick. Middle section, 9 ft. 6 in. high, 7 in. internal diameter, $\frac{1}{4}$ in. thick. Top section, 7 ft. 6 in. high, 6 in. internal diameter, $\frac{1}{4}$ in. thick.

C. Base section, 17 ft. 6 in. high, 10 in. internal diameter, $\frac{7}{16}$ in. thick. Middle section, 9 ft. 6 in. high, 8 in. internal diameter, $\frac{3}{8}$ in. thick. Top section, 7 ft. 6 in. high, 7 in. internal diameter, $\frac{5}{16}$ in. thick.

The excavation for the bases of the poles was 2 ft. 6 in. in diameter for a depth of 6 ft. 6 in. At the bottom of this a stone slab 6 in. in thickness was placed, the excavations afterwards being filled with concrete. The bases of the poles are of an ornamental character, the letters, W.U.D.C. being cast as a monogram. The bracket arms are of solid drawn seamless steel tube, $\frac{3}{16}$ in. thick and $2\frac{3}{8}$ in. external diameter. These vary in length according to the width of the road. Ornamental scrolls, collars, and finials give a neat and pleasing appearance to all poles. The trolley wire is of hard-drawn copper ·406 in. in diameter, and is divided by means of section insulators into half-mile sections, these insulators being fixed at points near the switch pillars. Each section is controlled by an independent switch, and connected to a busbar on the section pillar switchboard. The trolley wire is double throughout, and is suspended upon the flexible system at a height of 22 ft. 6 in. above the rails. Where side brackets are used the wires are 1 ft. 6 in. apart, the extreme horizontal distance from the trolley wire to the centre of the corresponding track being 7 ft. Where span-wire construction is used the trolley wire is suspended for centre running except, of course, at the turn-outs. Span and guy wires are of galvanised steel (7/12 S.W.G.), the guard wires are of 7/16 S.W.G., and are earthed to every fifth pole, which is bonded to the rail. The earthing is carried out by 3/0 S.W.G. copper bonds. Feeder poles are earthed in the same manner.

Special attention has been paid to the quality and manufacture of the frogs, crossings, ears, etc. These are all of bronze of the highest quality, specially designed and adjusted to ensure even working at all points of the system, and were all manufactured by Messrs. Brecknell, Munro, and Rogers. At each of the seven termini the necessary mechanical frogs are provided for the automatic reversing of the position of the trolley pole with the reversal of the motion of the car. The necessity for performing the operation by hand is thus obviated.

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The section pillars are of the usual cast-iron type, and, in addition to the switches, cable connections, etc., they are each fitted with a lightning arrester of the magnetic blow-out type, and a telephone plug box, with hand combination transmitter and receiver.

Three negative feeder pillars are provided, each being fitted with the usual Board of Trade apparatus, including Elliott's recording ammeter reading from 0 to 20 amperes, an ammeter reading from 0 to 10 amperes, a battery capable of giving 6 amperes at 4 volts, a double pole change-over switch, and a 300-ampere quick-break knife-pattern switch with insulating handle. Each of these pillars is connected with the rails by stranded cable connections, these being jointed to eight Neptune bonds, four to each rail. The usual earth plates are provided.

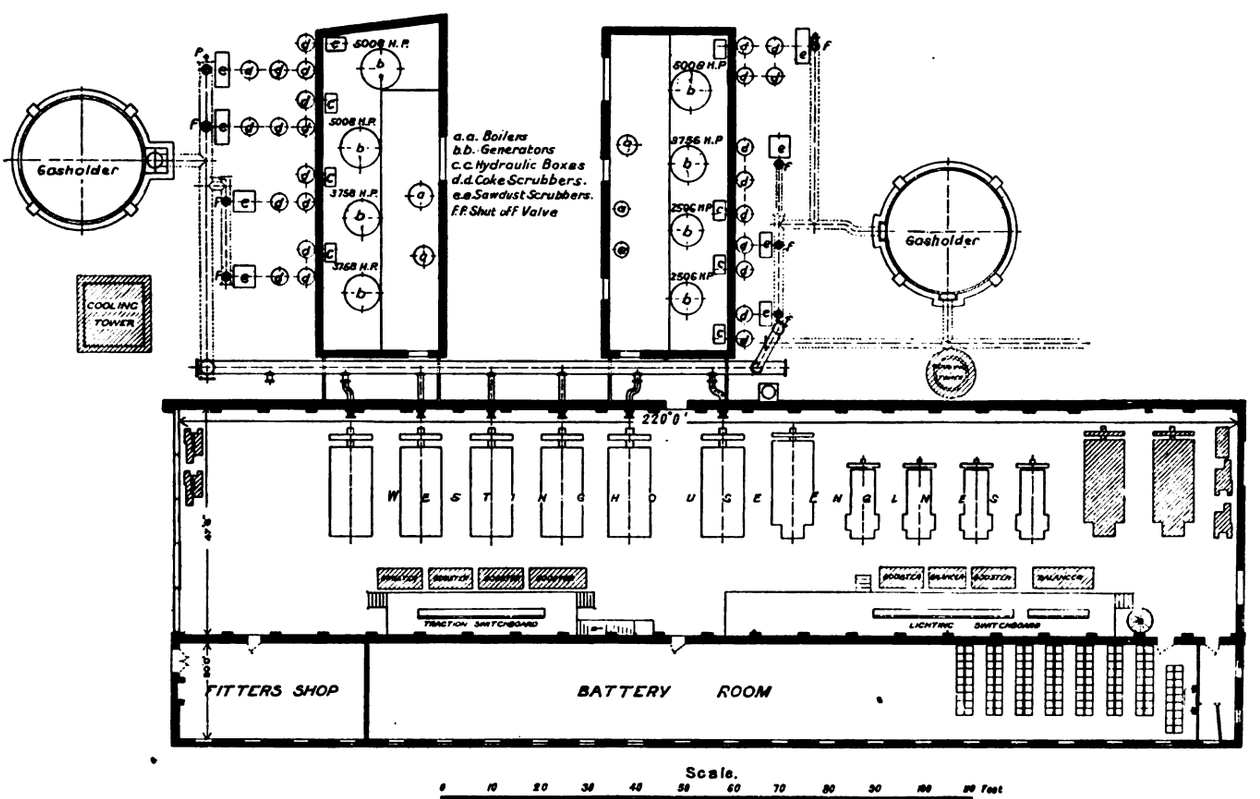

Fig. 5.—General Plan of Power-Station.

GENERATING STATION.

For the purpose of providing current for the tramways, the Council's electricity works in Priory Avenue have been extended. For some time past a very successful public and private lighting undertaking has been run by the Council, a number of Westinghouse three-cylinder vertical gas engines being installed for that purpose. These develop about 1,200 B.H.P., and are operated by Dowson gas.

The additional plant installed for the traction load consists of three Dowson gas producers, three three-cylinder Westinghouse gas engines, jointly developing about 800 B.H.P., and three Helios dynamos. A general plan of the power-station is shown in Fig. 5.

Though Walthamstow is, we believe, the first place in the United Kingdom to use gas engines exclusively for driving dynamos for tramway traction, the adoption of such a plant was no innovation for the District Council. Their real innovation was made four or five years ago when they approved of plans for their electric lighting station involving the use of Westinghouse gas engines. At that time this make of engine was not produced in this country, and the Westinghouse gas engines, which were then imported and installed at Walthamstow, appear to have given every satisfaction.

Up till now there have been in use in connection with the electric lighting work two Dowson gas producers of 200 H.P. each and two of 300 H.P. each. The new installation, supplied by the Economic Gas and Power Company, consists of four gas generators of the same type of 350 H.P. each, one of which is to aid in the lighting work, while the other three are for the tramways. The plant is housed in a new producer house. For supplying the steam for the producers, two vertical cylindrical boilers have been erected, each of 80 H.P. The steam from the boilers passes through superheaters, and is then led by pipes to the gas producers. Before entering the fire chamber the steam is mixed with the proper quantity of air, and is then passed through the fire, where the usual chemical action takes place, resulting in the production of great quantities of gas, a large proportion of which is atmospheric nitrogen and inert, the remainder being the gases from the coal and the

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hydrogen from the steam, the oxygen of the steam and of the air being combined with the carbon of the coal to form carbon monoxide. The producer chamber is circular in shape and built up of iron plates. Anthracite coal is used and is fed in both above and below by a feeding hopper and a movable hearth, and a deep fire is employed. The supply of air and steam is regulated by a valve according to the demand on the plant. Each generator can consume 500 lb. of anthracite per hour. From the generators the gas passes first into vertical cylindrical coke scrubbers, and then into square sawdust scrubbers. These are situated outside the building but close to the wall, and they filter and purify the gas so as to make it ready for use. The gas then passes into a small gasometer in the yard, and thence by pipes to the various engines. The gasometer is not used for storage purposes, but merely as a distributing centre. A view of the

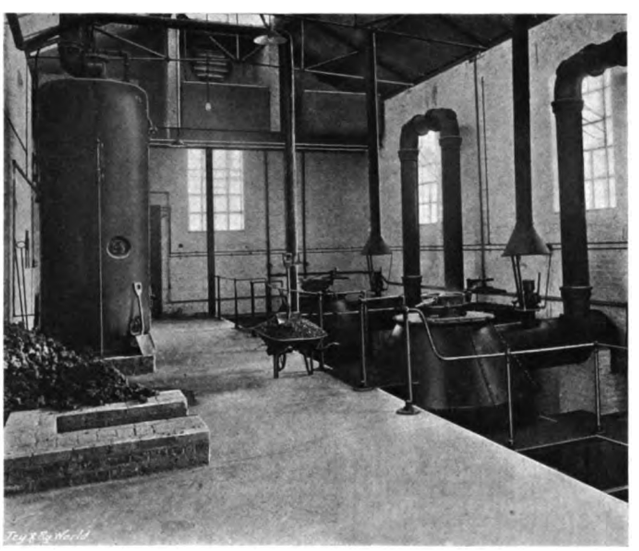

Fig. 6.—Dowson Gas Producer House.

gas producers and one of the boilers is given in Fig. 6, while the scrubbers are shown in Fig. 7.

A large water tank, which has been erected in the yard, is supplied from an artesian well 480 ft. deep. The water is brought up by one of Isler's double-acting pumps, driven by a 40 H.P. British Thomson-Houston motor. As the public water supply is also available there is thus a double supply for the three Balcke and one Westinghouse cooling towers which cool the circulating water, which in its turn keeps cool the cylinders of the gas engines.

The new engines are of the vertical, three-cylinder, single-acting type, operating on the four-cycle principle, which provides for an explosion in each cylinder every second revolution. The cranks being set at angles of 120 deg., the crank shaft receives impulses at regular intervals of two-thirds of a revolution. This uniformity of impulse is a special feature of the Westinghouse gas engine. Instead of the hit-or-miss type of governor the gear is so arranged as always to maintain the full number of explosions, and to regulate, in direct accordance with the load, the quantity of mixed gas and air admitted to the cylinders. A mixing chamber is fitted to the engine, in which the correct proportions of gas and air to give maximum efficiency are adjusted by suitable hand valves.

The governor is of the fly-ball type, and is driven by a half-speed shaft actuated by gearing. Its action consists in operating a valve which controls the supply of the gas mixture to the engine in proportion to the load. The governing has been found to be excellent, the speed variation for all loads being within 2 per cent.

Ignition is effected electrically, the current being derived from small dynamos direct coupled to motors, or, as an alternative, from primary batteries. Large silencers are provided for the exhaust, and consist of iron tanks fitted with baffle plates.

The engines have been designed specially to reduce vibration to a minimum. Compressed air is used for starting the engines, and for this purpose it is stored in vertical tanks placed against the engine room walls. Each of the smaller generating sets is provided with a separate compressor, but others are also installed, being driven by electric motors. The starting operation is simple, one of the engine cylinders being used for the time being as a compressed air engine. This is effected by the movement of a valve which shuts off the gas from the cylinder and admits compressed air. The cams controlling the exhaust valves are shifted in starting in such a manner as to allow the valves in the remaining cylinders to open during the compression stroke, which permits the engine to accelerate smoothly. The compressed air is turned off, and the exhaust valves returned to their normal working condition as soon as an explosion occurs in one of the cylinders, and the engine then runs up to full speed. The cylinders are water jacketted, and the cooling water is passed through a small cooling tower to a pond, whence it is again pumped through the engines by motor-driven centrifugal pumps.

Each end of the engine and crank shaft is provided with a fly wheel, that at the back having slots cut in the periphery for barring round by hand. A view of the new engines and dynamos is given in Fig. 8.

The maintenance and repairs item of the Walthamstow costs has been very low up to the present.

The four new dynamos are Helios machines, supplied by Messrs. F. Suter and Company. They are ten-pole machines, and each is rated at 185 KW. The speed is 200 revolutions per minute. The frames are of steel, and each field core has two separate coils upon it in parallel with an air space between them. A break down in one coil would thus still allow the other to do at least a share of the work of magnetisation. An unusual feature in these traction dynamos is

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that they are shunt wound instead of compound wound, and this arrangement has been rendered possible by the fact that a Highfield booster and a storage battery form part of the plant, and equalise practically all load fluctuations so far as the dynamos are concerned. Of course, the field magnetisation, and consequently the voltage of the generators, can be regulated by hand within a considerable range by means of a switch, which varies the strength of the shunt.

The Highfield booster set, made by the Electric Construction Company, runs at 1,000 revolutions per minute, and produces a pressure of 120 volts, its normal load being 200 amperes, though it can work up to 400. The booster machine is at one end of the shaft, the motor in the centre, and the exciter at the other end. The motor is connected to the busbars of the switchboard while the booster is connected with a Tudor storage battery of 244 cells with 300 ampere-hours' capacity. This type of apparatus has been described in great detail in connection with the City and South London Railway electric plant, and it is hoped that the good results obtained by its use there will also be got at Walthamstow. It is sufficient here to recall the fact that essentially the office of the booster is to aid the storage battery in equalising the load on the generators. When the load is light the booster aids in charging the battery, while when the peaks of the load come on the battery discharge on to the line is aided and strengthened by the booster.

In connection with the three negative feeders from the rails, three negative boosters of Helios make have been installed. In the case of two of these, each can give a current up to 300 amperes at any pressure up to 40 volts, while the third is equal to 185 amperes at 30 volts. The motors which drive the boosters are guaranteed to take safely an overload of 50 per cent. for two hours and a momentary overload of 100 per cent.

A separate switchboard, supplied by Messrs. F. Suter and Company, has been erected for the tramway work. It consists of thirteen white marble panels, including four for the main generators, three feeder panels, two Highfield booster panels, three negative booster panels, and the Board of Trade panel. Weston ammeters and voltmeters, Thomson-Houston recording wattmeters, and the other usual instruments are provided.

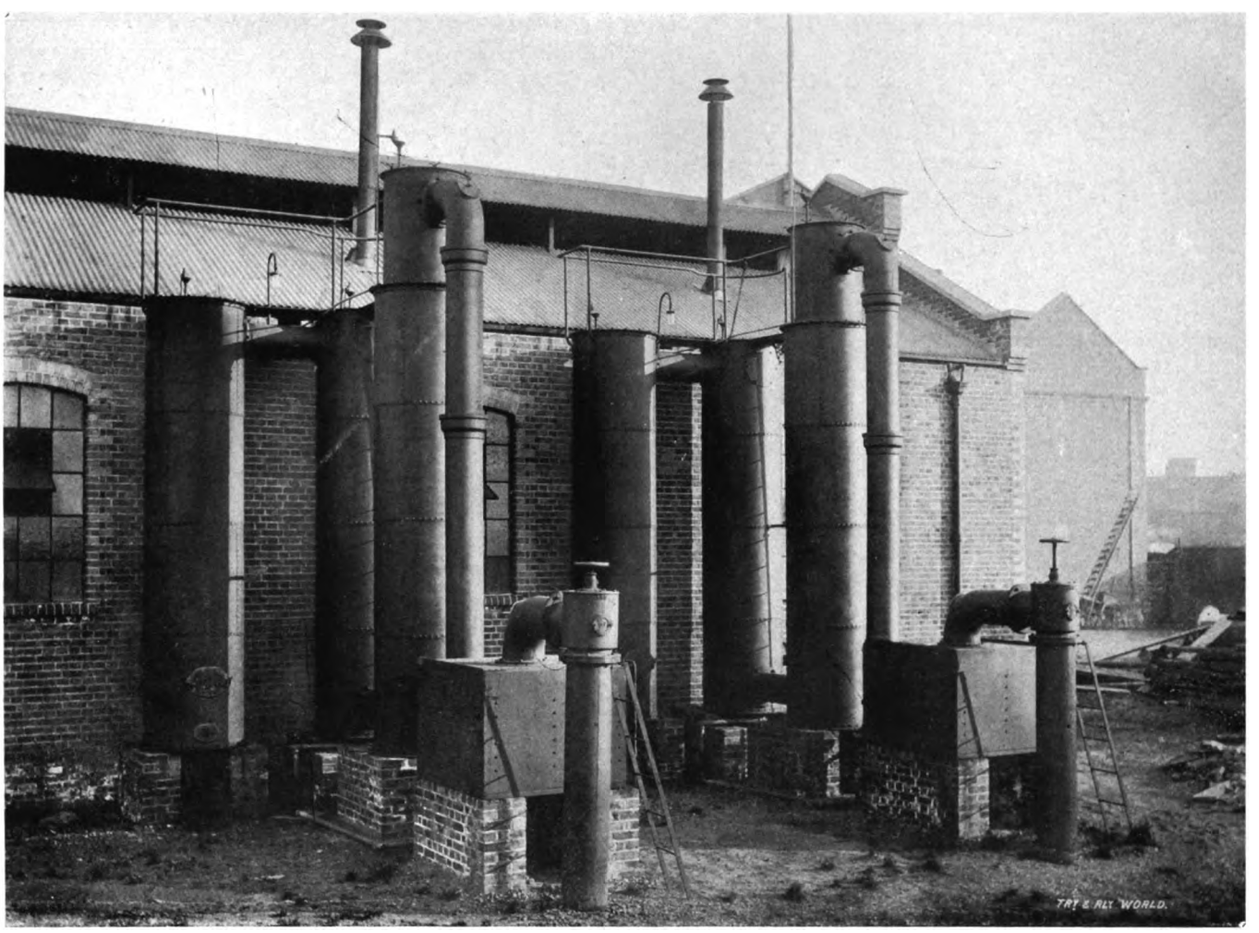

Fig. 7.—Coke and Sawdust Gas Scrubbers.

CAR-SHED, SHOPS, AND OFFICES.

The car-shed, repair shops, and tramway offices are situated in Chingford Road, some distance north from the power-station, and their general arrangement may be gathered from the drawings, Figs. 9 to 13. The car-shed is 120 ft. long by

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93 ft. wide, and has eight tracks which can accommodate four cars each. The pit, which is floored with concrete, runs across the entire breadth of the building, and the floor between the tracks and the rails are supported on brick piers. The building is lofty, airy, and well lighted, and this remark applies also to all the repair shops. The latter include a joiners' shop, a fitting shop with an equipment of machine tools and a 10-ton travelling crane, a paint shop which can accommodate four cars at a time, an armature-winding shop, a smithy, and general stores. The offices, which are not yet quite ready for occupation, consist of the manager's room, clerks' room, ticket office, cashiers', conductors', motor-men's, and inspectors' rooms, clothes store, etc. The whole of the office buildings measure about 120 ft. in length by 40 ft. in breadth.

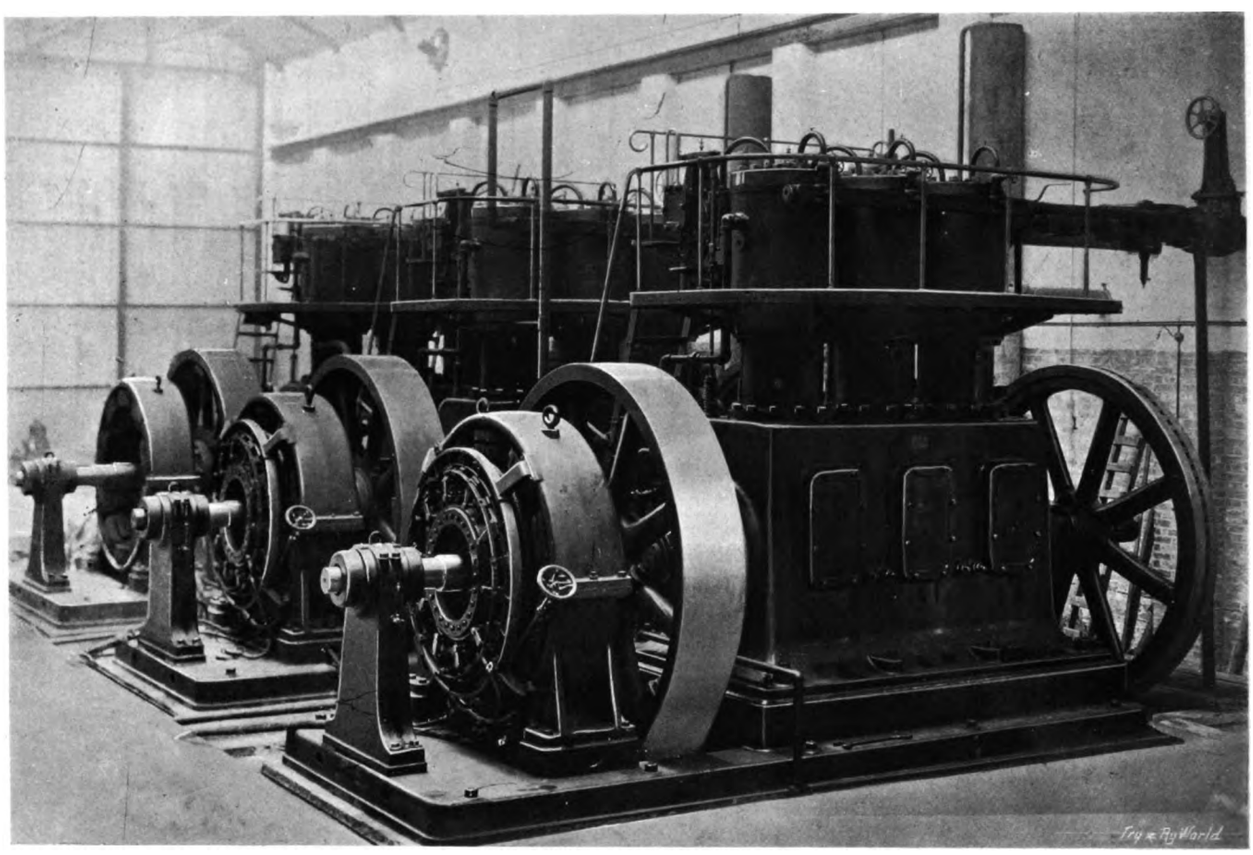

Fig. 8.—Gas Engines and Dynamos—Traction Units.

ROLLING STOCK.

Up till the present 32 double-deck single-truck cars have been supplied. The bodies and trucks are of the Brush Company's manufacture. The length over all is 28 ft., the length of the body 17 ft., and the extreme width 6 ft. 7 in. The cars are plainly and neatly finished inside, the roof being of polished maple and the seats of perforated veneer. There are eight electric glow lamps inside and six outside, making fourteen per car. Four of the outside lamps by means of "bulls'-eyes" in the backs of the destination indicators, light the top decks. All the cars are fitted with Philipson's life-guards, which were fully described in our article on West Ham tramways, in our issue of April 6 last. Each car can seat 52 passengers, namely, 24 inside and 28 outside.

The electrical equipment of the cars, which is of British Westinghouse manufacture, includes 46 M motors, 90 M controllers, and magnetic brakes. The Westinghouse No. 46 M motor, as installed on the Walthamstow cars, is of a special design to suit the conditions of tramway traffic on city streets, and is adapted for all gauges of track down to a minimum of about 3 ft. The field consists of four laminated soft steel poles cast into a cast steel yoke, which is divided in a horizontal plane through the armature shaft. These two halves are hinged together on the side opposite the axle, thus rendering the interior parts of the motor easily accessible. The field winding consists of coils wound upon moulds and thoroughly insulated with fullerboard and mica, and each coil is held in place by a cast brass plate bolted to the yoke.

The armature is of the slotted drum type, wound with two-circuit winding, and ample ventilation is secured by openings extending through the core parallel to the shaft, and also by the arrangement of the winding. The coils of which this is composed are machine wound, and thoroughly insulated from each other. Three individual coils are wound separately, and then enclosed together in a protecting cell of

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insulating material, which is placed in the core slots without any bending or hammering. The ends are open, allowing free air circulation.

The commutator is built up of hard-drawn copper segments insulated by sheets of mica. It is of considerable diameter, allowing a good margin for wear, and there are a large number of segments with a corresponding low voltage between each, which decreases the liability of flashing over. The brush holders are specially strong and rigid, and are fixed to the upper field casting with provision for radial adjustment.

The bearings are carefully proportioned to reduce wear and heat, and are placed outside the motor casing in order to prevent oil from reaching the armature and field windings. In addition to the grease cup above the bearing, an oil reservoir with a wick feed is placed under it, thus making it possible to use either oil or grease, or both for lubrication.

The gears and pinions, which are composed of cast and forged steel respectively, are wide faced, and have been proportioned as regards pitch and form of teeth in a manner that provides ample strength for the severest class of tramway work.

The 90M type of controller embodies the principal features of the 90 type but is slightly modified, having additional steps on both power

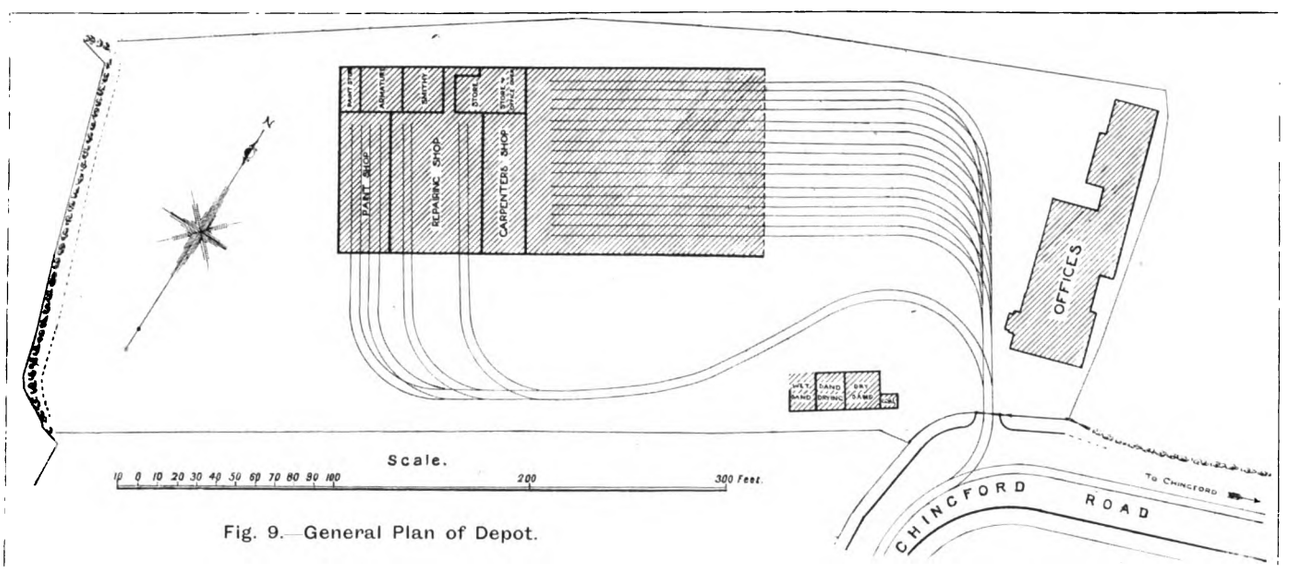

Fig. 9.—General Plan of Depot.

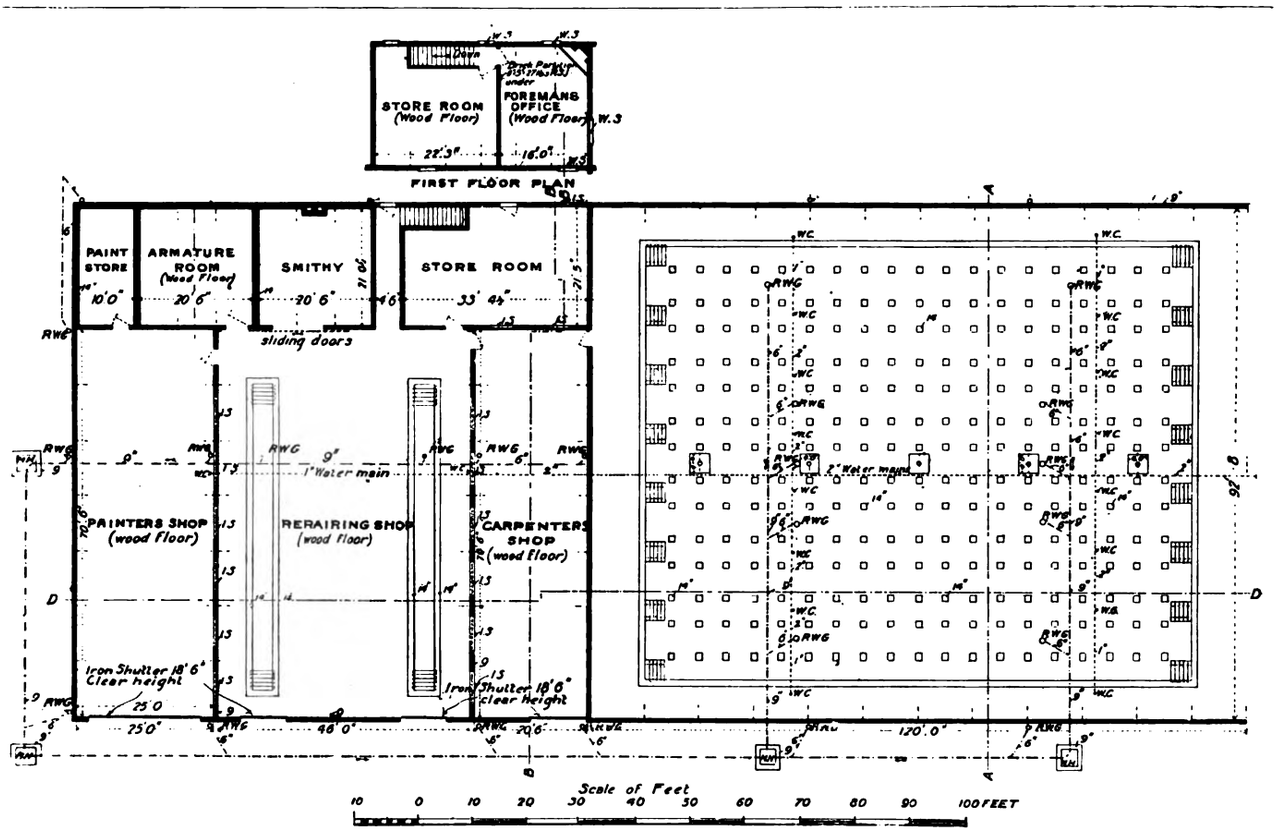

Fig. 10.—Plan of Car Shed and Repairing Shops.

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and braking sides. The controller is arranged to control the motor in the following four ways: Normal forward car running, normal backward car running, normal forward car braking (running motors as generators), and normal backward car braking. These changes are secured in the 90M. controller by a different arrangement of connections than those used in any other type. Fewer contacts are required in this controller than is usual; mechanical connections between the operating and reversing levers, automatically operated, take their place, and the reversing switch and the motor cut-out switch are combined. The advantages of such an arrangement are less wear and tear of contacts and greater freedom from breakdown risks.

In operation, the movement of the handle in one and the same direction from the "off" position produces either forward or backward normal running according to the position of the reversing lever; and its movement in the opposite direction results in braking whether the running is forward or backward. The simple throwing of the operating lever back beyond the "off" position secures the braking effect, the change from running control to braking control being effected by mechanical connections between the main operating drum and the reversing drum of the controller.

The 90M controller is of the series parallel type with five series and three parallel steps. In the braking position there are seven steps, and retardation is carried out by running the motors as generators and utilising the current to actuate the magnetic track brake. The controller is of the usual drum construction with cast-iron base, cast brass top, and asbestos-lined sheet-iron case. The contact fingers are protected by spark guards of special arc-resisting material, so that arcing from finger to finger or to the case is impossible. Renewable tips are fitted to all the fingers, and are so formed and fixed as to be easily replaced and adjusted.

The cars are fitted with the Westinghouse magnetic track brake which is quite independent in its action of the current in the line. Should the latter be cut off even when the car is running down a steep incline, the brake will speedily bring it to a standstill by aid of the current generated by the motors running as dynamos and used in the brake itself. In its action the brake is as positive at two miles per hour as at twenty miles per hour. It may be recalled that the brake consists of three elements, (1) a track magnet fitted on each pole with a detachable soft steel shoe, which runs just clear of the rails and energised by the current generated by the motors; (2) brake blocks of the ordinary type acting on the periphery of the wheels; (3) a simple link mechanism connecting the track and wheel shoes, by means of which the downward pull and consequent drag on the rails of the former is transmitted to the latter which operate in the usual way. The whole brake is flexibly suspended by helical steel springs from the truck frame, and the track shoes, which only clear the rails by ¼ in., are thus allowed to ride over any obstructions encountered. A general view of a car fully equipped is given in Fig. 14.

A combined track sweeper and water car (Fig. 15) has been supplied by Messrs. Brecknell, Munro, and Rogers. It is fitted with Jerrard's

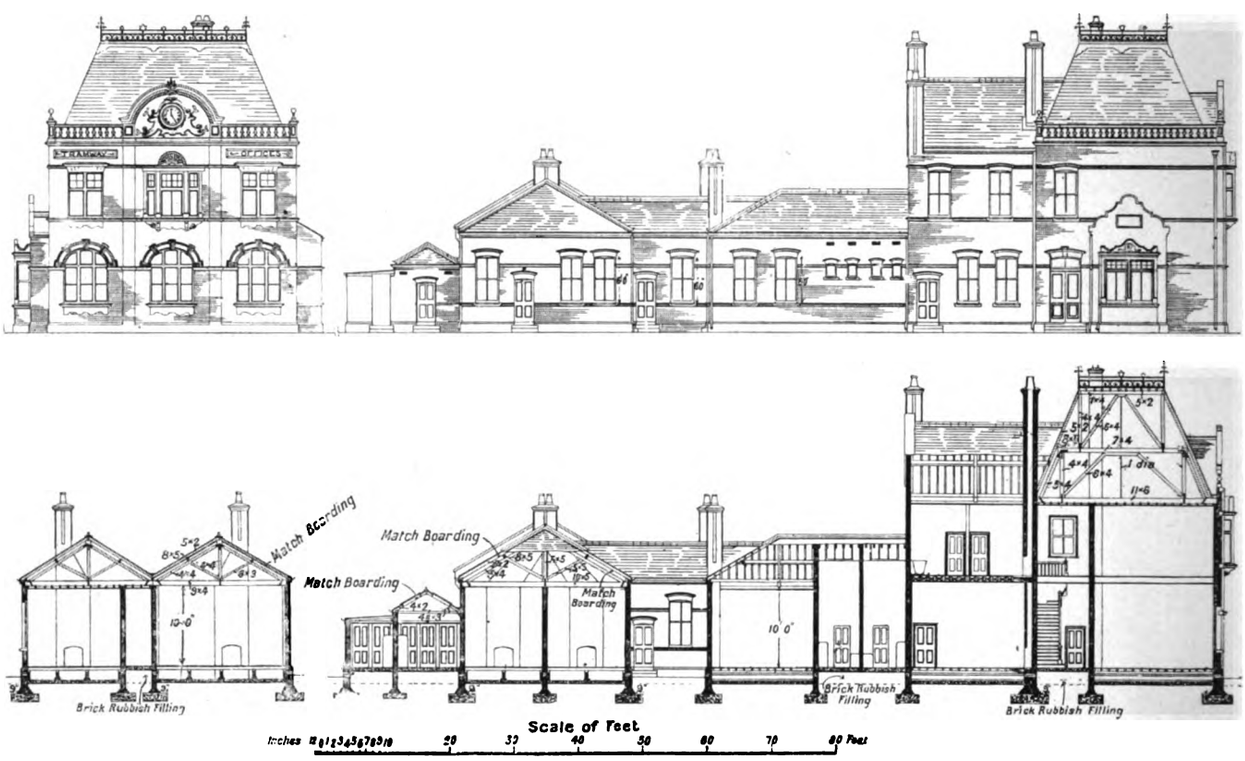

Fig. 12. Elevation of Offices.

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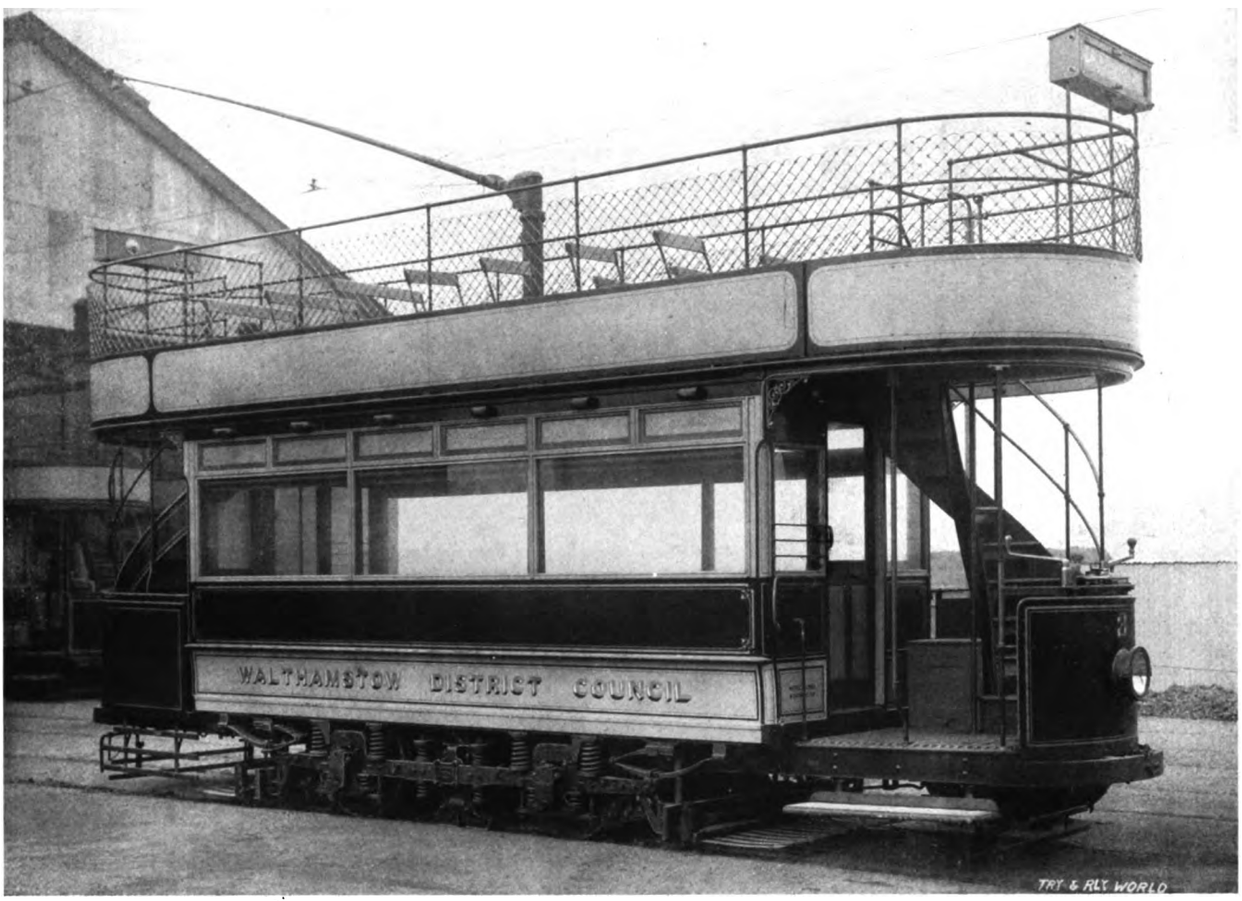

Fig. 14.—Walthamstow Car.

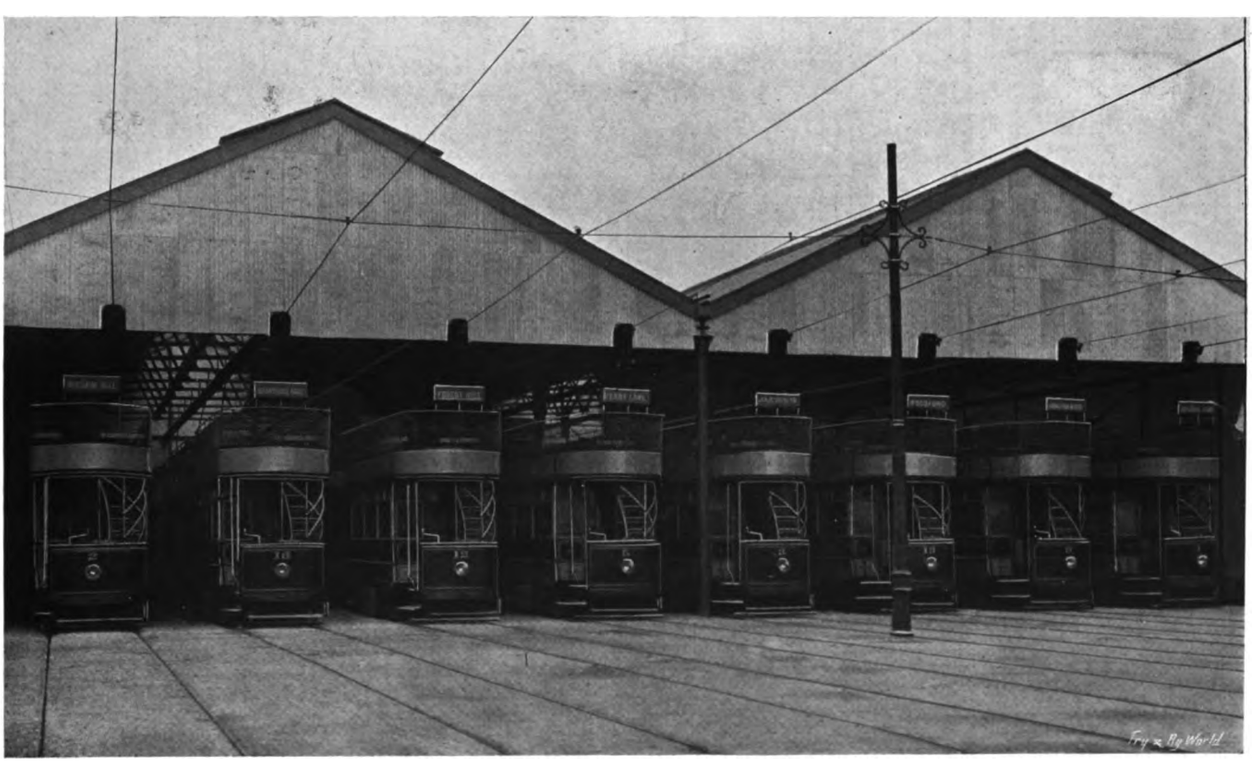

Fig. 11.—Eight-Track Car Shed.

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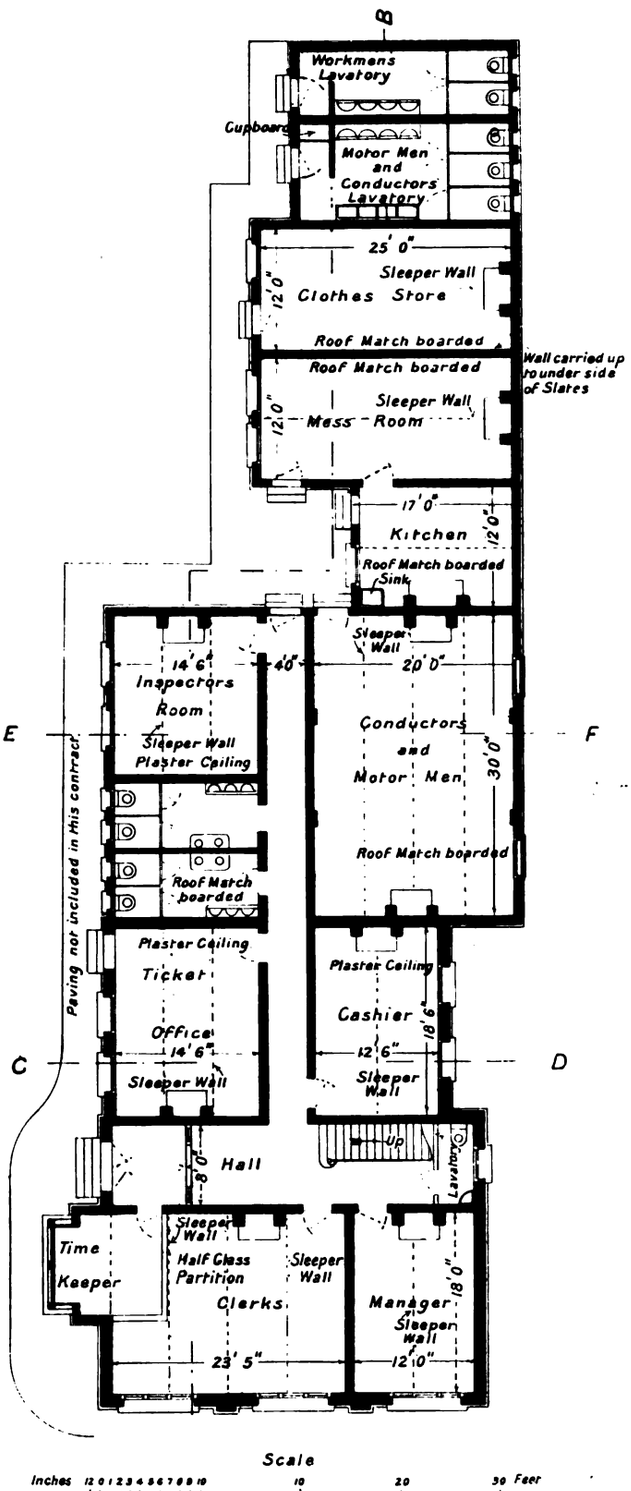
track cleaners, and the body is supported on a Brush Company's truck. The iron water tank holds 1,500 gallons. The magnetic brake has been fitted as in the case of the passenger cars, and there are four Westinghouse motors, two of the usual type below for driving the car, and one



Sig. 13.—Plan of Offices.

mounted on each platform for driving the large sweeping brushes. These latter motors, which are quite independent of the traction ones, are of $7\frac{1}{2}$ H.P. each, and each one drives its own brush by means of a Renold's silent chain.

Mr. G. W. Woolley, the chairman of the Traction Committee, and Mr. Wilkes, chairman of the Council during the past year, deserve great credit for the personal interest they have taken in the work. Mr. J. H. Fooks-Bale, M.I.M.E., M.I.E.E., entered upon his duties as electrical engineer and tramway manager in the beginning of the present year, and since then he has been actively engaged in the work of organisation and in making arrangements for the beginning of the working of the tramways, which will take place very shortly. There appears to have been considerable delay in getting work completed, but the responsibility for this does not lie with the manager.

A very useful little pocket-book of instructions to drivers and conductors has been prepared by Mr. Fooks-Bale, and by following it the men need seldom be at a loss what to do. The book gives a simple description and explanation of the various parts of a car, particularly the electrical equipment, together with detailed instructions as

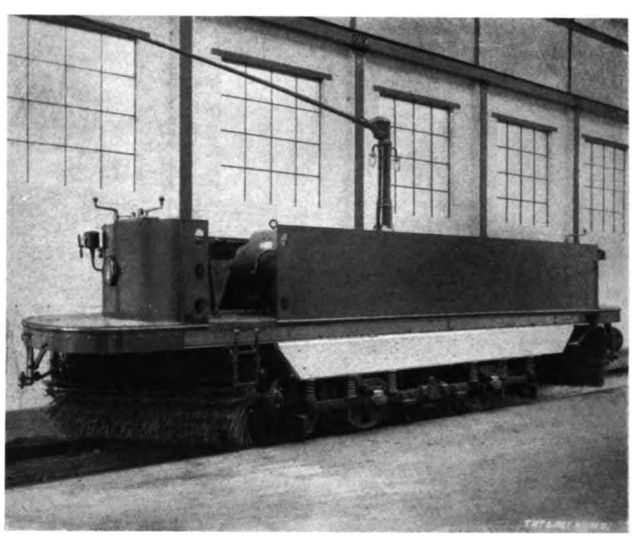


Fig. 15.—Watering Car and Sweeper.

to what should be done in the different cases of breakdowns which occur to a car. The conductors have special rules and orders set out for their guidance. As an appendix there are three folding diagrams mounted on cloth, showing the electric tramway circuit and the connections of the controllers. Possibly the latter could not be understood by the ordinary driver if left to himself, but the book is intended to be used as an aid to the tuition given orally and experimentally by an instructor.

FERRANTI, LIMITED.—The scheme of reconstruction of this company has now been carried out, and the directors and principal officials of the new company are as follows: Directors, A. W. Tait, chairman (director of Messrs. Bruce, Peebles and Company, Limited), Arthur Whittaker, J. M. Henderson (director of Messrs. Thos. Bolton and Sons), and S. Z. de Ferranti, M.I.M.E., M.I.E.E., M.I.C.E. General manager, A. B. Anderson. Chief engineering staff, Michael B. Field, M.I.E.E., A.M.I.C.E., A.M.I.E.E., America; W. Hamilton, B.Sc., W.Sch.; C. C. Garrard, Ph.D., A.M.I.E.E. The business of the company will henceforth be confined to the manufacture of switch gear (with all necessary accessories), transformers, instruments, and meters; but in order to meet the convenience of the customers of the old company, arrangements have been made for dealing with the maintenance and repair of engines and alternators supplied by them.

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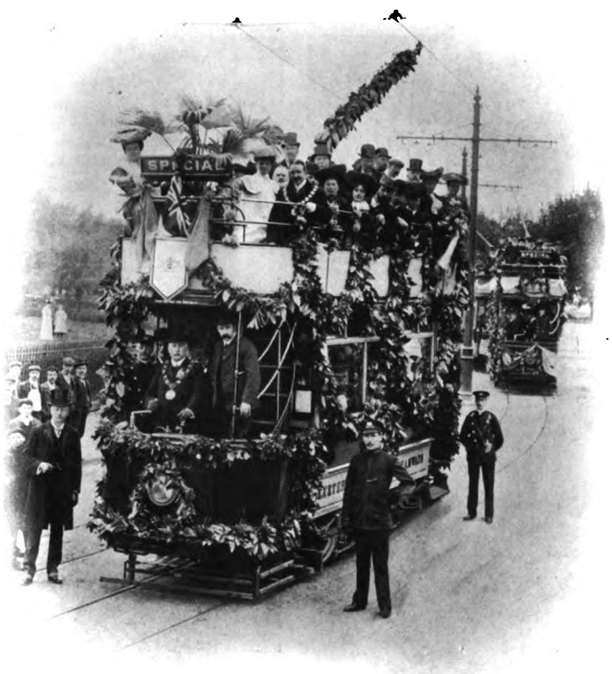
EXETER CORPORATION TRAMWAYS.

Tramways in Exeter date back to 1885, when a company was formed locally and after much opposition succeeded in obtaining an Act under which a short section of line was constructed. This section did not include a tramway in High Street—the most favourable route from a financial point of view—and the original company found it impossible to earn its working expenses. A second company did not have much better success, and after some years of precarious existence, relieved from monotony by disputes and negotiations with the Council, it sold the undertaking to the Corporation. By an Act obtained in the Parliamentary Session of 1903, the Council had meanwhile secured power to lay new lines, to construct extensions, and to equip the whole system on the overhead electric trolley system. A battle royal was fought over the question of constructing tramways in High and Fore Streets, and the opposition before the House of Lords was continued even after a poll of the ratepayers had resulted in a large majority in favour of the Council's proposals.



Procession of Decorated Cars at the Opening of Exeter Electric Tramways.

Mr. H. D. Munro,
City Electrical Engineer.

Mr. W. Hederstedt,
Chief Officer of Exeter Corporation Tramways.

Mr. Thos. Moulding,
City Engineer.

A comprehensive system of tramways had been proposed, but only the trunk lines were included in the first contract. These lines included the routes from Dunsford Gate at the west end of Cowick Street, to Pinhoe Road, via Fore Street, High Street, Sidwell Street, and Blackboy Road, and from St. David's Railway Station, via Queen, High, and Paris Streets, and Heavitree Hill to Livery Doll. Subsequently terms were arranged with the Heavitree District Council for an extension of the tramways through the main street of that suburb.

A portion of the routes enumerated above has now been completed, and the remainder is under construction. The completed lines cover 4½ miles of street, and have a track length of 6⅝ miles, as there is 2⅛ miles of double line, including a short section of interlacing track. Messrs. Dick, Kerr and Company were the contractors for the permanent way, and they have carried out the construction in accordance with the usual standards. The gauge of 3 ft. 6 in. was adopted as best suited to the somewhat narrow streets of Exeter. The rails, which are 6 in. in depth, and weigh 90 lb. per yard, are laid upon a foundation of cement concrete 6 in. deep, and are packed up to the proper level by fine cement concrete averaging ¾ in. in thickness. All the special track work and the points and crossings were supplied by Hadfield's Steel Foundry Company, of Sheffield.

The road between the rails and for a distance of 18 in. on each side of the rail is paved with Welsh and Devonshire granite setts, except in Queen Street, High Street, Sidwell Street, and

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Cowick Street, where hard wood paving is used. Throughout High Street, and in parts of Queen Street and Cowick Street, wood paving is also used.

The steepest gradient is in Fore Street, where the ratio is 1 to 11½ and 1 to 13. In St. David's Hill and Pinhoe Road are gradients of 1 in 16 and 1 in 19 respectively. At the corners of Queen Street and Paris Street are curves of only 35 ft. radius.

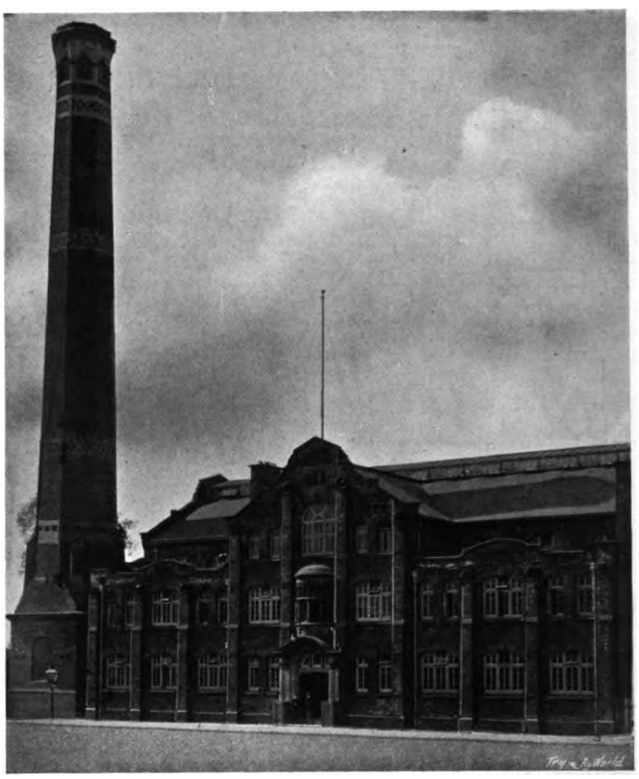
The overhead equipment is of the usual type. The trolley wire is supported from centre poles, side poles, or span wires as most convenient at various points on the route. For the greater part of the distance the trolley wires are hung centrally over the tracks, but occasional deviations are made, the trolleys being of the swivelling type. Double insulation is used throughout. All section wires are connected telephonically with the generating station and the car shed, and the usual Board of Trade test wires are extended to the end of the routes. These wires are laid underground as far as the feeder conduits extend, and are then continued as small overhead wires attached by brackets and insulators to the poles. The usual mischievous guard wires are fixed—as required by the Board of Trade regulations – above the trolley wires wherever the latter are crossed by telegraph or telephone wires.

Messrs. Dick, Kerr and Company have supplied the rolling stock, which at present consists of 12 single truck cars of the double deck type,

View Along High Street, from Queen Street Corner, Exeter.

each car having a seating capacity of 20 passengers inside and 22 outside. The reversed stairways, seating accommodation, and ventilation are all carried out in the way usual in Preston cars. Each car is 26 ft. long, and weighs 8½ tons.

The cars are equipped with 25 H.P. motors, and are provided with the ordinary hand brakes, in addition to the Westinghouse magnetic track brake. A somewhat novel precautionary device



Exterior of Power Station.

is an electric apparatus which automatically prevents a car from running backward on a gradient when the electric current from the line has been cut off.

All the cars have Philipson's patented lifeguard and folding step, which were described and illustrated in the account of the West Ham Corporation tramways, given in our issue of April 6. The folding step interlocks with a folding gate on the platform in such a way that step and gate must move together. It is thus impossible for the gate to be opened before the step is in position, a very necessary condition wherever folding steps are in use. The cars are painted in dark green and gold, and have the city arms emblazoned on the side panels in the usual way.

Car-sheds and offices have been erected at a point nearly at the centre of the tramway routes. The building is of brick with Portland stone dressings. The roof is carried on steel stanchions and steel lattice girders, and is glazed with Rendle's patent glazing. The building provides space for 15 cars, various repair shops, stores, etc. The offices comprise a committee room, a manager's room, general offices, conductors' room, and the other usual accommodation. To provide for future needs, the south east side of the shed is constructed of wood between steel stanchions, so that extension can easily be made by removing the wood and erecting new steel members.

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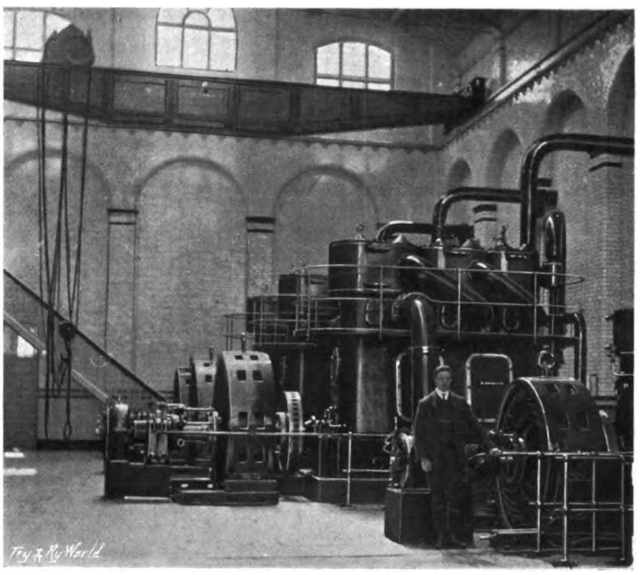
As the power for working the cars is taken from the municipal electricity works, the description of the purely tramway equipment has now been given, and we may summarize the cost of the work. The figures as given in an official report are as follows:

Track, including wood paving	£34,000
Overhead equipment ..	4,700
Feeder cables	3,000
Cars (15) ..	7,000
Car shed and buildings	5,700
	£54,400
Additional generating plant	4,000
	£58,400

Taking the track length of the tramway as 6⅜ miles, the average per mile is thus approximately £9,100 per track mile.

The new electric power-station of the Corporation, which was opened about a year ago, will be utilised as a source of supply for the tramways. The building is of pleasing design, and covers a space of about 150 feet square. As will be seen in the accompanying illustration, the station has three bays, one forming the boiler-room, another the engine-room, and the third containing the offices. There are annexe buildings for the economisers, boiler feed pumps, etc. The chimney is 155 ft. high, and has an internal diameter of 8 ft. 6 in.



Interior of Engine Room.

The boiler room is 102 ft. long, 55 ft. wide, and contains six water tube boilers, fitted with superheaters, capable of supplying steam for 2,700 H.P. The steam ring is so arranged that any boiler or engine can be isolated without interfering with the working of the others. From the main flue behind the boilers, the waste gases pass through the economisers and thence to the chimney.

A complete mechanical system has been provided for handling the coal. It is first delivered into shoots, which convey it to the automatic filler of the gravity bucket coal conveyor. The latter is electrically driven, and conveys the coal to the coal bunkers above, which hold 500 tons. From the hoppers it is dropped in measured amounts to the hoppers of the chain grate stokers.

Interior of Boiler Room.

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The arrangements are well shown in our illustration of the boiler-room. The chain grates, driven by electric power, carry the coal into the furnaces, and also discharge the ashes and clinkers into the basement, whence the conveyor removes them to the ash bunker. The stoker will burn the cheapest kinds of coal without smoke.

The engine-room is a spacious building of 102 ft. by. 45 ft., well lighted, and lined throughout with glazed bricks, with a floor of "Terrazzo" marble paving. The room is spanned by an overhead travelling crane with a capacity of 10 tons.

There are at present four Westinghouse alternating-current generators coupled direct to vertical compound engines, with a total capacity of 1,300 KW. One of the machines is a 200 KW. alternator, which has been installed to supply the tramway requirements, and there is also a motor generator of equal capacity for converting the current for the tramways. This machine has been supplied by Messrs. Bruce, Peebles, and Company, and is of a novel type which dispenses with static transformers.

Forced lubrication is used in all the engines. The exhaust steam is dealt with by jet condensers in the basement. Water for these is taken from a large well outside the building which is connected with a basin, into which the water is again discharged after use.

Current from the generators is led by cables in stoneware conduits beneath the floor to the switchboards, from which it is distributed by the main feeder cables. There are separate switchboards of Westinghouse manufacture for the lighting and traction services.

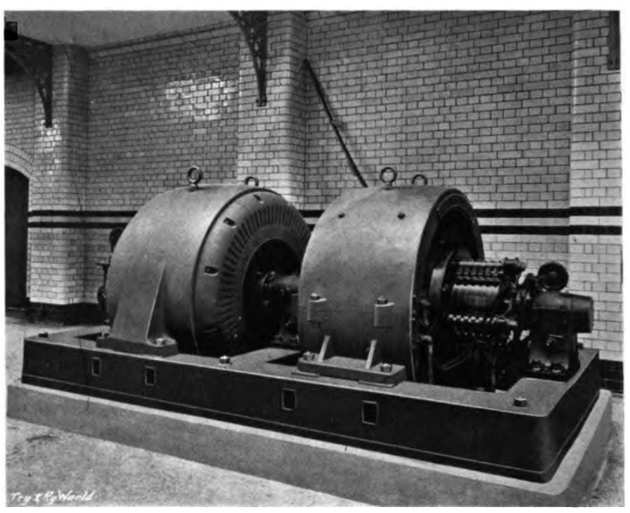
Current for the tramway service is being supplied at a price of 1⅞d. per unit for the first

Exeter Electric Car with Philipson Guard.

100,000, and 1¾d. per unit for all energy beyond this quantity. Instruments for measuring the current are placed on the switchboard.

Upon Mr. E. C. Perry, Mayor of Exeter, and chairman of the Tramway Committee, has devolved the responsibility of providing the city with a modern tramway system; and to his devotion to the work the citizens are much indebted for the excellent service that is now being provided.

The construction work has been carried out to the specifications of the Council's engineers, Mr. J. C. Waller, consulting engineer; Mr. Thomas Moulding, city engineer and surveyor; and Mr. H. D. Munro, city electrical engineer,



Motor Generator.

acting jointly. The city officials supervised the actual construction, and to Mr. Munro we are indebted for particulars and photographs embodied in this description.

The organisation of the tramway department has been carried out by Mr. W. Hederstedt, who has been appointed chief officer of the tramways and consulting engineer to the Corporation for the administration of the system.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The Incorporated Municipal Electrical Association will hold its tenth annual convention at Edinburgh and Glasgow from June 27 to 30, at the North British Railway Hotel, Princes Street, Edinburgh. The following is the preliminary programme issued by Mr. C. McArthur Butler (secretary), Staple Inn Buildings, Holborn, W.C.:

TUESDAY, June 27.—(Edinburgh).—*Morning*: Presidential address, reading and discussion of papers. *Afternoon*: Visits to electricity works. *Evening*: Reception by the Lord Provost, Magistrates, and Council.

WEDNESDAY, June 28.—(Glasgow).—*Morning*: Reading and discussion of papers. *Afternoon*: Visits to electricity works.

THURSDAY, June 29. (Edinburgh).—*Morning*: Reading and discussion of papers. *Evening*: Members' annual dinner.

FRIDAY, June 30.—(Edinburgh).—*Morning*: Annual general business meeting (members only).

The following are some of the subjects to be discussed during the Convention: (1) Load factor—its effect upon an electricity station; (2) Street lighting; (3) Extensions to outlying areas; (4) Free wiring and supply on the prepayment system; (5) Allocation of costs; (6) The supply of electricity in industrial areas, from a municipal point of view.

INSTITUTION OF CIVIL ENGINEERS.—The Council have made the following awards for papers read and discussed before the Institution during the past session: Telford gold medals to Lord Brassey, K.C.B., and Mr. C. S. R. Palmer; a George Stephenson gold medal to Mr. Lyonel E. Clark; a Watt gold medal to Mr. J. F. C. Snell; Telford premiums to Messrs. L. F. Vernon-Harcourt, M.A., R. W. Allen, and Wm. Marriott; a Crampton prize to Mr. A. Wood-Hill, and the Manby premium to Mr. E. D. Pain.

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NEW TYPE OF COMBINATION CAR FOR SALFORD.

The Electric Railway and Tramway Carriage Works, of Preston, have just supplied to the order of the Salford Corporation Tramways a new type of combination car, which possesses some interesting features. The total length over body is 31 ft. 6 in., with a platform at each end for the motorman 2 ft. 9 in. long. The car is so arranged that it allows for an open compartment in the centre, for the use of smokers, and also a closed compartment at each end for non-smokers. All compartments are fitted with teak lath and space garden-type seats, with reversible backs, with a gangway down the centre of the car.

Each closed compartment has a seating capacity of 12 and the open compartment of 24 passengers, making a total of 48. The interior of the closed compartment is handsomely finished in teak and oak. Doors are arranged at each end, the one leading on to the platform being arranged to swing, while the one leading into the open compartment is of the sliding type. Over each door there is arranged an ornamental head-piece, handsomely designed, with embossed mouldings, etc.

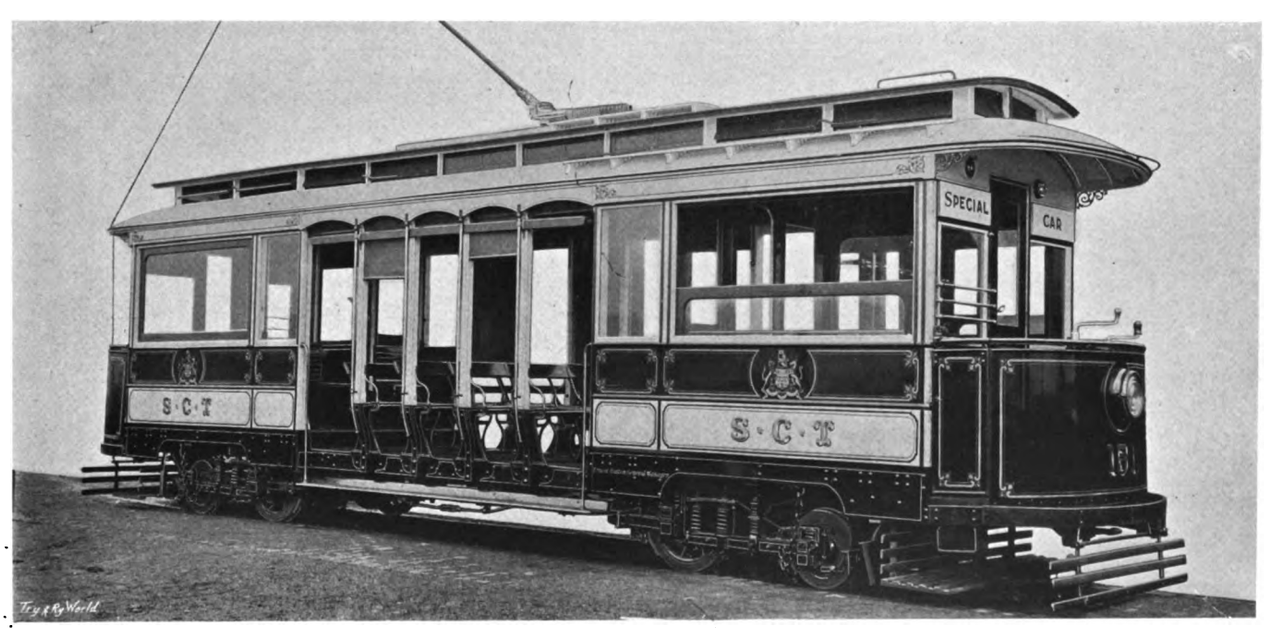
The ventilation has received special attention. In addition to having the usual line of pivoted ventilators on each side of the clerestory roof, the large windows are arranged to drop. An efficient raising and lowering device is provided, which enables the windows to be opened to any desired position from the driver's platform. Parcel racks are provided on each side, with brass brackets of ornamental design.

The finish of the open compartment is similar to that of the closed compartments, but between the pillars are arranged waterproof spring roller blinds, which can be drawn down to the floor, making practically a waterproof compartment. The ceiling of each compartment is of millboard, with Lincrusta borders, handsomely picked out in colours and harmonising with the general finish of the car as a whole.

The underframe of the car is built up of steel

Salford Combination Car—Interior.

channels and oak members, and is carried on two Brill maximum-traction trucks. Steps are arranged, running the full length of the open compartment on either side, from which access is given to both closed and open compartments. Serviceable grab handles are provided on each pillar on either side of car. All the necessary



Salford Combination Car—Exterior.

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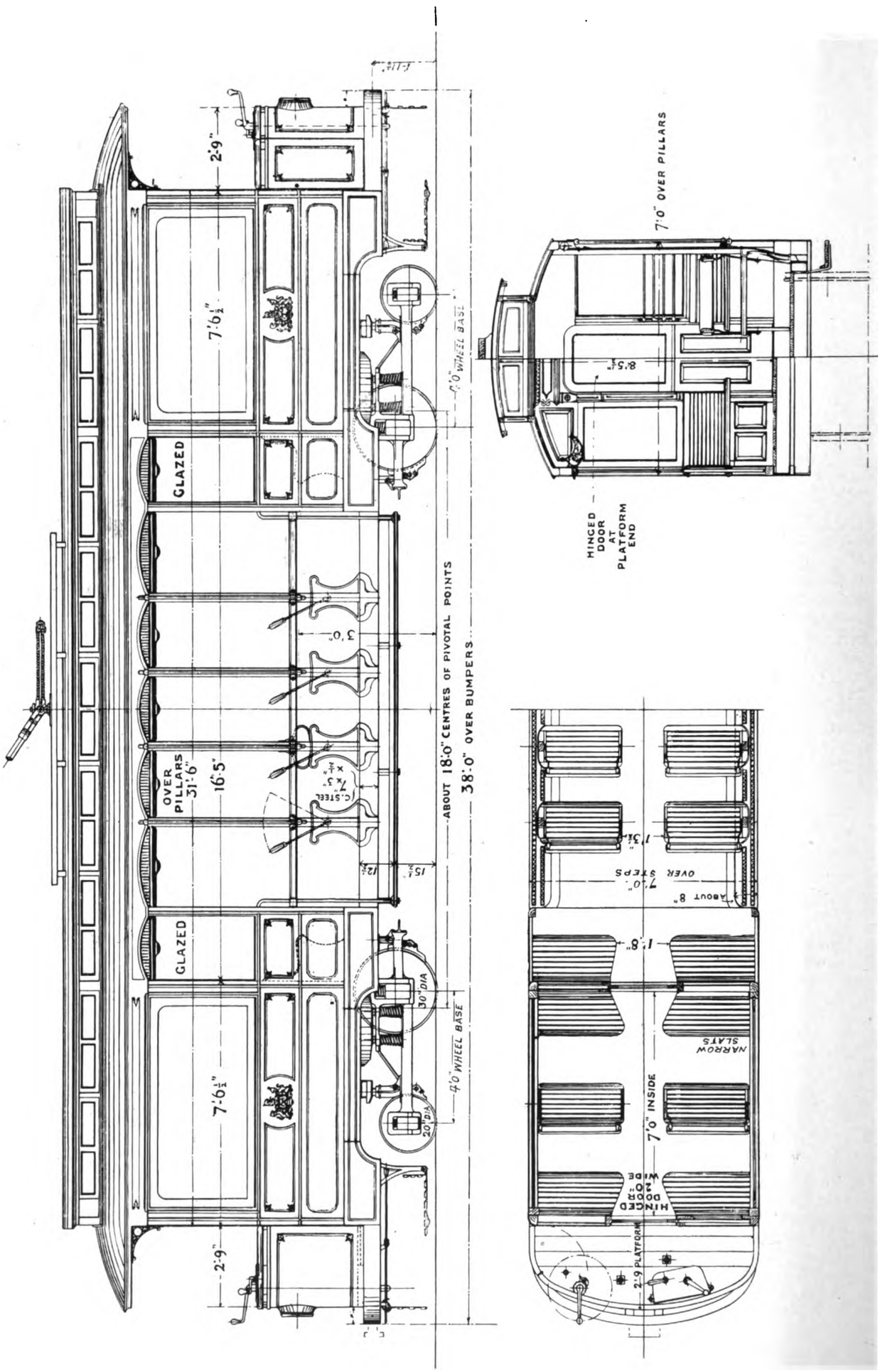

Elevations and Plan of Salford Combination Car.

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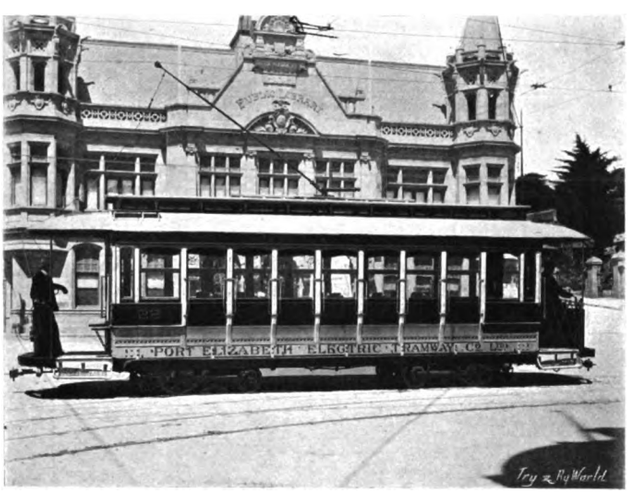
platform equipment is supplied, including Salford standard lifeguards.

The exterior of the car is tastefully decorated, picked out in colours and lined. On the centre of each compartment are placed the borough coat-of-arms and other decorations in accordance with the Salford Corporation Tramways practice.

The detail dimensions and general appearance of the car may be readily gathered from the accompanying drawings and photographic views.

CONVERTIBLE CARS AT PORT ELIZABETH.

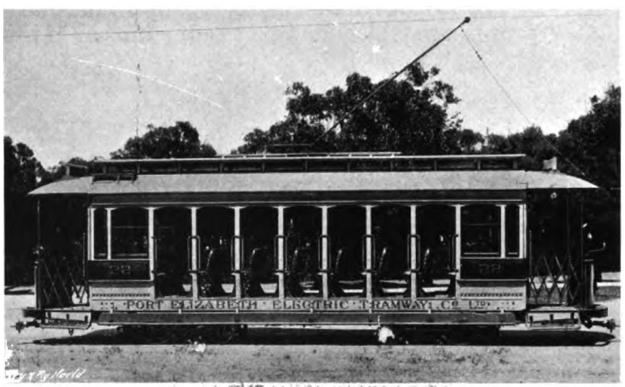
The interesting photographs here produced were taken at Port Elizabeth, South Africa, and show cars of the patented convertible type built by the J. G. Brill Company. One of the cars is seen in front of the handsome public library, and the other at one of the entrances to the public gardens. The city is situated on Algoa Bay, about 425 miles east of Cape Town. There is a fine harbour with excellent wharfage, and



Port Elizabeth Car with Panel Down.

railways connect the city with important towns in the interior. The climate is sub-tropical with a considerable rainfall during the wet season. The main streets of the city parallel with the waterfront are level and have many fine buildings, while the streets which run at right angles climb a series of gradients to the higher levels where the residential districts are reached. A high mountain range parallels the coast a few miles distant and forms a background to the city which never fails to excite admiration when first seen from the deck of vessels approaching the harbour.

The tramways are controlled by the Cape Town Electric Tramways, Limited, and the rolling stock consists of cars of the type shown in the illustrations. The first lot was supplied by the Brill Company more than a year ago, and the second lot was received recently. It speaks well for the cars that they are unaffected by the alternating heat of the summer and the moisture laden atmosphere of the rainy season. Two sizes of the cars are used, those on double trucks measuring 25 ft. 9 in. over the bodies, and those on single trucks, 23 ft. 2 in. The trucks are of the builders' "Eureka" maximum-traction and No. 21-E types, and the cars are furnished with seats, gates, sand boxes, bells, draw irons, buffers, and other patented specialities of the same manufacture. Both sizes of cars are arranged with seats for three passengers each at the corners, thereby giving ample aisle space near the door to prevent crowding. The seating capacity of the shorter cars is 32, and of the longer cars 36. Seats are provided for four additional passengers on the platforms, these seats being arranged to fold against the end panels. The platforms of the shorter



Port Elizabeth Car—Open.

cars are 4 ft. long, and the double truck cars have 4 ft. 3 in. platforms. The interiors are finished in dull cherry with bird's eye maple ceilings. The seats are upholstered in spring cane and have backs of the step-over type, so arranged that the operating levers at the aisle end do not come in contact with the bodies of seated passengers.

A TEXT BOOK OF APPLIED MECHANICS.*

The appearance of a fourth and enlarged edition of this excellent students' manual is good evidence of its popularity. In order not to delay the issue of the book the additional matter has been added in the shape of a separate appendix of 184 pages in which various new matter is dealt with, including a description of the water-driven centrifugal dryers of Watson, Laidlaw and Company, and also of the electrically-driven machines of the same firm.

There is further information on roof trusses, on the catenarian curve, on finding girder stresses, on testing machines, etc., and on micography, all of which sections are well illustrated and, in particular, actual modern machines are employed for illustration, a plan which no doubt helps the student who is not actually engaged in practice. As usual, there are copies of recent examination papers for entry to the Institution of Civil Engineers, though we would not wish to imply by this that the book is not suitable for the man in practice. Indeed, men engaged at work are constantly finding that they have become rusty along some or other line, and they will find such a book as this most helpful in getting back to principles. The author is to be congratulated both on the book and on his industry in preparing it.

THE DIESEL ENGINE.—A booklet issued by the Diesel Engine Company, Limited, 179, Queen Victoria Street, E.C., is a record of substantial progress. When first introduced, in 1890, it did not make much headway, but within the last few years it has thoroughly established itself in popular favour. It is estimated that there are now 1,200 engines at work, with a total output of 75,000 B.H.P. The standard sizes range from 20 to 500 B.H.P., the over-all dimensions ranging from 6 ft. 11 in. by 7 ft. 7 in. by 6 ft. 11 in. to 25 ft. by 13 ft. 2 in. by 13 ft. 9 in. An engine of 500 B.H.P. coupled direct to a dynamo will be exhibited at Liege this summer, and the company have now under construction engines of 750 and 1,000 B.H.P.

* A Text-Book of Applied Mechanics, Vols. I and II. By Andrew Jamieson. Fourth Edition. London: Charles Griffin and Company, 1905.

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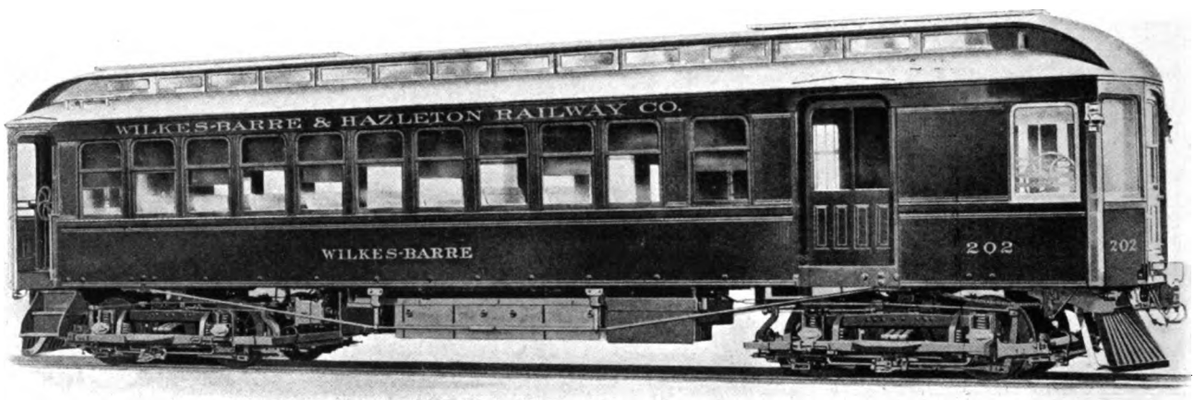
THE BRILL 27-E TRUCK.

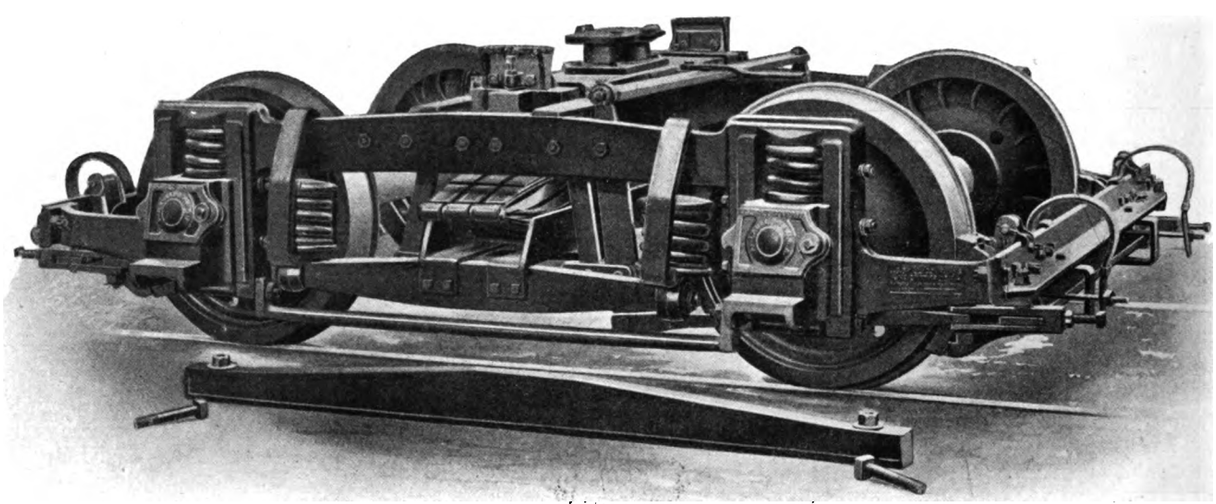
Under the title of "A perfectly equalized truck for heavy electric and steam service," the J. G. Brill Company, of Philadelphia, have issued a handsome illustrated pamphlet descriptive of various types of their 27-E truck for heavy service. The company's trucks for tramway work are widely and favourably known in this country, and it is of interest to note here some of the features of those designed for railways. The 27-E truck was first employed on American electric railways nearly ten years ago, when it was adopted on the Buffalo and Niagara Falls line. It speedily became a favourite with passengers owing to its easy riding qualities, and since then it has come into wide use all over the United States. Of course it has undergone many developments and improvements, though its original features remain the same. These features include three sets of springs working in series, spring-link suspended equalising bars, and cushioned side swing. The solid forged side frames maintain absolute squareness when in service.

When electric railways first began to develop, short-base trucks, similar to those used for tramway cars, were employed, but as the speed of cars increased the need of equalised trucks became apparent. The truck used on steam railways was tried, but it was found that in consequence of the arrangement of the springs the application of the brakes caused the frame to be pulled down at one end and pushed up at the other. This produced a tendency to derailment, especially with the shallow wheel flanges and narrow treads used on high-speed trucks. The Brill Company, after numerous experiments, produced the 27-E type, which completely reversed the old system of equalisation, by suspending the equalising bars from the frame instead of supporting the frame on the equalising bars. Finding it necessary to give up riveted and built-up frame constructions, which were not equal to high-speed requirements, most of these Brill trucks were for the first few years built with cast-steel frames. For several years the cost of solid forged frames was considerably more than that for cast-steel frames, and therefore the latter were chiefly employed, but the cost of solid forging having been reduced to the level of that of the cast frame, all 27-E trucks for the past two years have been built with solid-forged side frames.

A cast-steel frame is equal to strains from every direction and keeps the truck square. It is, however, not proof against crystallisation, and, sooner or later, succumbs to the poundings, joltings, and vibrations. Blow holes may exist in the metal without possibility of detection. An electric motor truck has to withstand



Brill Trucks Under Heavy Railway Car.



Brill Truck for Heavy Service, Collector Shoe Support Detached.

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more severe shocks and vibrations than a locomotive frame, and it carries a comparatively much heavier load.

The solid forging process, developed and perfected at large expense, realised the company's highest expectations. They claim that they are the only builders of trucks which have each side frame, including side bars, yokes, and extensions, solid forged in a single piece. Of the many thousands of solid forged side frames that they have made, only a fraction of 1 per cent. have broken or needed repairs.

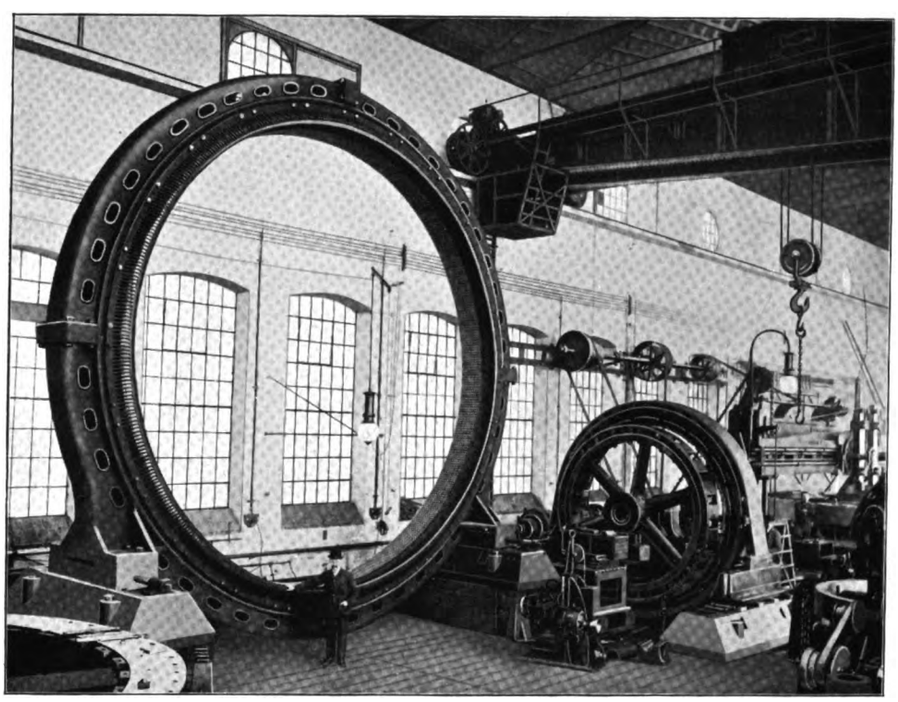
The double and single corner brackets that are employed are forged from single billets. The transoms and end pieces are of heavy angle iron, and all parts are bolted together in a manner which ensures great strength and rigidity. The holes are drilled to a smaller diameter than is required, and reamed to a size which necessitates the bolts being driven in. Crown nuts are then screwed on over spring washers and are transfixed with cotter pins.

The spring system comprises three sets of springs working in series, each having to do with the equalisation, and not only is the load perfectly equalised on the wheels, but it is also equalised on the frame. This is obtained by bringing the load to bear upon the side frames at wide apart points near the yokes instead of at the centres, thereby holding the frames down upon the journal springs with a leverage against the wheels and brakes. Besides producing an effective leverage in favour of stability, the placing of the links near the yokes relieves the centres of the side frames of much of the strain; in other words, the load is carried on the side frames close to the points, where they themselves are supported. Being outside the wheels, they furnish a wider link base than is possessed by other trucks; this steadies the car on curves by diminishing the rocking motions of the elliptics. At the same time they amplify the vertical motion of the elliptics, thereby imparting smoother motion to the car body. At the entrance to curves the spring links swing outwardly, and at the end of the swing the springs in the links are compressed, drawing the car body gently out of the line of its momentum into the new direction without the usual jar and lurch which wrench the body. The wheel flanges are thus not forced violently against the rail heads. This fact, together with the equalisation, accounts for the truck never having been derailed except in collisions.

The equalising bars and spring plank are rigidly secured together, forming a cradle for the bolster. The links which suspend this cradle from the frame enclose the equalising springs. The load is equalised upon the frame before it is equalised upon the wheels, an extra set of springs being employed which nearly doubles the vertical spring action, and the arrangement is such that never, even under severe conditions, are the wheels released from the high leverage exerted upon them by the frame. Various instances have occurred when cars using these trucks have run safely over obstructions maliciously placed on the rails. The makers strongly recommend this truck alike for steam railways, elevated electric railways, and heavy suburban and interurban lines.

A LARGE ALTERNATOR FOR THE LONDON COUNTY COUNCIL.

The very large alternator armature which is illustrated below is now being constructed for the London County Council, by the Electric Construction Company, Limited, of London and Wolverhampton. Hitherto, when anything out of the ordinary run of electrical machinery has been required, buyers have often placed their orders either in America or on the Continent, and the London County Council is to be congratulated on allowing a British firm to show how unnecessary, so far as large dynamos are concerned, it is for public corporations and others to send their orders to foreign markets. This plant is amongst the largest, if not the largest, that has yet been called for. In all, the Electric Construction Company are making four of these three-phase generators, each designed to give a continuous output of 3,200 KVA., at a speed of 94 r.p.m., and periodicity of 25 complete cycles per second per phase. The output of 3,200 KVA. is to be rated with a power factor of 94 per cent. The working pressure is 6,600 volts, and the current per phase 280 amperes. The machines will be called upon to give an overload for two hours continuously of 25 per cent. additional current, that is 350 amperes per phase. The field magnet system is constructed directly upon the rim of the engine flywheel, in which the amount of stored energy, when revolving at normal speed, is 11,000 foot tons. The Electric Construction Company are constructing the complete flywheel.



Armature Ring of 3,200 KVA. Alternator.

SOUTH LANCASHIRE TRAMWAY EXTENSION.—Colonel von Donop, on behalf of the Board of Trade, on April 19 inspected the new section of the South Lancashire Tramways Company's service between Tyldesley and Boothstown, and the section was opened for traffic on the following day. It is now possible to travel nearly all the way from Manchester to Liverpool by electric car.

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THE
Tramway AND Railway World

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We shall be pleased to receive at all times articles, papers, notes, and correspondence on subjects of interest to those concerned in the financial administration, construction, or management of tramway and light railway undertakings. Particulars as to the issue of specifications, the progress and completion of contracts for new work, and suggestions for improvements in all branches of tramway enterprise will receive special attention.

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LONDON, MAY 4, 1905.

The Universal Penny Fare.

The report by Mr. Nance, which we publish in this issue, strongly recommending the Corporation of Belfast to adopt a universal penny fare on the tramways, is worthy of the careful consideration of every tramway manager and tramway authority in the country. Fortunately for Belfast, there have never been halfpenny fares on the tramways, so that if a uniform fare of a penny for any distance is adopted there will be no outcry by people accustomed to ride half a mile or more for a halfpenny. Thus, while the change would bring no increased charge on any passenger, it would materially benefit those who travel longer distances than the present penny stages. The highest fare in Belfast is threepence, so that there is ample opportunity, by means of a penny fare, of encouraging traffic over the longer distances and leading people to live in the suburbs rather than in the centre of the city. Mr. Nance points out with great effect the many benefits to be derived from a universal penny fare, both by the public and by those carrying on the operation of the tramways. Upon such benefits we have frequently insisted, but hitherto Hull affords the only example (and it is highly successful) of a tramway system of considerable importance which has the universal penny fare in operation. The present average fare per passenger in Belfast is 1·14 pence, which is a little below the average of many large towns. The loss, by adopting a uniform penny fare, would thus be ·14 of a penny, but Mr. Nance clearly shows how this may be expected to be more than recouped by the larger number of passengers owing to the lower fare and owing to the adoption of electric traction. His estimate of increased business is a very modest one, and yet he is able to show that after paying all working expenses and setting aside interest, sinking fund, and depreciation allowances there will be a probable balance for relief of the rates of £50,000.

* * *

Taking the run of municipal tramway systems the country over, it is not very wide of the mark to say that the average fare per passenger is about 1¼d. In the case of some of the largest towns, where halfpenny fares are in use for short stages, the average fare, despite the length of the routes, is less than a penny. In such towns the wisdom of abolishing the halfpenny stages and instituting a penny fare for any distance is self-evident, but it is not an easy task to withdraw the halfpenny concession once it has been granted. At the same time it is of no material advantage. The hardship of having to walk half-a-mile because one has to pay a penny instead of a halfpenny to ride for that distance cannot be weighed against the numerous advantages of the uniform penny rate. As to towns where there are no halfpenny fares, the circumstances of each one would of course have to be considered in the light of local conditions, but we remain of opinion that in a great many cases the uniform fare would prove an immense advantage. A material increase in the number of passengers travelling long distances would be inevitable, while there would be considerable saving in the traffic expenses owing to the simplification of the ticket system. Probably a saving could also be affected in the matter of inspectors, as fewer men might be necessary when their work would be confined to seeing

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that each passenger had a ticket, as the question of riding further than the ticket entitled would not arise. We are convinced that sooner or later the uniform penny fare for urban, as distinguished from interurban lines, will have to receive a wide trial.

Tramway and Motor Car Speeds.

The Tramways and Light Railways Association have again tried to convince the Board of Trade of the hardship of strictly limiting the speed of tramway cars, while automobile vehicles are allowed to rage through the land, but their efforts have not met with any success. It is quite evident that a great deal more pressure is required before success can be attained. In one sense time is on the side of the tramway authorities, because as time goes on motor omnibuses will become more plentiful, especially in suburban and rural districts, and the absurdity of allowing a 'bus a speed 50 to 100 per cent. greater than that allowed to a tramcar will become more and more manifest. There is one aspect of the question which should be emphasised. The records published in the daily newspapers show how numerous is the class of irresponsible, reckless drivers of motor cars who rush through towns and villages scattering destruction and death. Far from being content with the liberal allowance of twenty miles an hour granted by a Legislature largely and personally interested in "motoring," these drivers appear to think nothing of thirty miles an hour. The tramway car has to plod along at its Board of Trade allowance of from eight to twelve miles an hour. Yet, apart from the safety to the public from the fact that the car is confined to its rails, the drivers are all regular employees of the tramway company or local authority, as the case may be, are under strict supervision and discipline, and are liable to penalties up to dismissal if found guilty of negligence or recklessness.

* * *

It is obvious that in various directions there is added safety to the public from the inability of the tramway car to deviate from the rails, but one may be noted in which there is absolute safety, whereas in the case of the motor car there is much danger. Among the numerous accidents caused by motor cars a common one arises from a motor car suddenly emerging from behind a slow-moving or stationary vehicle. The motor car overtakes this cart, and then swerves out from behind it to the right. If any other vehicle is coming in the opposite direction, or if a pedestrian is crossing the road, a smash is very apt to occur, as the motor car is not seen till it emerges from behind the cart. But if a tramway car overtakes a slow-moving vehicle which is on the track, the car has to slow down and crawl till the ringing of the bell succeeds in persuading the carter to pull over to one side. This is only a sample of things as they are. Taken broadly, the fast-running motor car is more or less of a menace to all other users of the road, while the tramway car is at the mercy of every obstructionist, and merely craves the opportunity to get along at a reasonable pace. When it comes on stretches of clear road carrying little traffic there is no good reason why it should not be allowed a much higher speed than ten or twelve miles an hour, even though no demand were made for the twenty miles at present enjoyed by the licensed libertine of the road.

Gloucester Tramways.

Useful Report.

The work shown by the Municipal Tramways Association and the Association of Municipal Treasurers and Accountants in establishing a uniform system of preparing tramway accounts is now beginning to have excellent results. Many towns have adopted the schedule, and many others will undoubtedly soon follow their example. Consequently a good deal of obscurity in municipal tramway accounts will vanish, and comparisons of results obtained in different parts of the country will become a much more easy matter. Hitherto municipal tramway returns have not always been prepared in such a way that the exact financial condition of the undertakings could be ascertained without various supplementary inquiries, and in some cases the suspicion was aroused that the ratepayers were not given all the information which might have been placed before them. No doubt if Parliament had ever seriously considered the question of municipal tramway management, it would have provided that the annual reports should be presented in accordance with a prescribed form. Railway companies are, of course, required to make their reports under a statutory schedule, and there is certainly no good reason

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why similar obligations should not be placed upon the tramway departments of local authorities. The voluntary adoption of the standard form will, however, make amends for the omission of Parliament in a way that will be much to the credit of tramway committees. The next step that municipalities should be encouraged to take is to appoint independent professional auditors of their tramway accounts. Gloucester Corporation has already done this, and the accounts and balance sheet for the year ending March 31, 1905, which has been issued with commendable promptness, is certified by a firm of chartered accountants. The undertaking is not a large one; but the Council do not propose to deal perfunctorily with the statistical and financial side of their undertaking, for they have appointed a separate accountant for the light railway department, whose signature is appended to the report, together with that of the city accountant and of the general manager. All these officials have apparently been anxious to give a full account of their stewardship, and the result is a publication which might serve as a model to many other tramway committees who may now be considering what form their accounts shall take. Gloucester should also afford encouragement to some of the small municipal systems because of the excellent results obtained. The undertaking is not more than a year old, but operating expenses per car mile will stand at 5·20d., notwithstanding the fact that the amount paid for power amounts to 1·43d. The revenue per car mile is at present no more than 7·43d., but that this will gradually increase there is no doubt whatever. When the actual earning capacity of the system is approached the city will have a valuable financial asset, as well as a great addition to its amenities.

Messrs. H. Lotery and Company, 4 to 8, St. Mary Street, London, N.E., have secured the order for the whole of the uniforms for the Lanarkshire Tramways Company.

Hudson and Bowring, Limited, of 33, Brazennose Street, Manchester, have received through the Brush Company a further order for lifeguards for ten Yarmouth cars; and also for the new cars for Plymouth. Hurst, Nelson and Company have also ordered "H-B" lifeguards for 12 cars on the Mansfield and District light railway, and for 15 cars on the Stalybridge tramways.

The General Electric Company, Limited, of 69-92, Queen Victoria Street, London, E.C., have issued a new catalogue and price list of electric fittings and fixtures. The book is a substantial volume of some 300 pages printed on art paper, and well illustrated with a bewildering variety of patterns for electric light fittings, etc. There are some particularly handsome designs, and a casual glance at the catalogue shows that the General Electric Company fully appreciate the advantages of artistic work.

CORRESPONDENCE.

The International Standardisation of Tramway Accounts.

To the Editor of the Tramway and Railway World.

Sir,—It is conceded that the only way to ensure progress is to compare results; but this comparison is useless unless it is a just and reasonable one; also the comparison is of little value unless it is based on extensive experience over a large field of operations—the larger the better. Now there have been three, if not four Associations that have with great industry thrashed out different standard forms of accounts, but they have all done this without, as it would appear, any close conference with one another. The American "company" and the English "municipal" forms are very much alike, but differ sufficiently to prevent useful comparisons. On many points the French form of the *Union Internationale* has been dismissed by the others as being too statistical, and that prepared by the Secretary of the Tramways and Light Railways Association as being too much an engineer's production. Statisticians and engineers being therefore so far ruled out of court, it now behoves the experts in accounts to put their heads together and to settle their little differences in a manner that shall be understandable by even statisticians and engineers.

As a result of their conferences the Institute of Municipal Treasurers and Accountants and the Municipal Tramways Association have adopted a most useful form of accounts which, no doubt, will be employed by most of the municipal undertakings in England. These forms were submitted to the Conference at Liverpool, but, in the short discussion that took place, there was no very clear enunciation of the principles on which they were drawn up, and there are many points which require elucidation; as, for instance, in the case of the capital account. What items can be fairly chargeable to this, or, in other words, where should the line be drawn between betterments, chargeable to capital, and ordinary renewals chargeable to revenue. Or, again, should the property be valued from time to time. If this were done, it would be possible to estimate whether the sums put aside for depreciation were too much or too little. That is, whether, if the concern were sold up, the sums so set apart would cover the difference between the original cost and the present value; if such sums were greater than this difference, contributions to the fund should cease. Then, as regards renewals. One kind can hardly be distinguished from maintenance, and may be called "partial:" the other is a "total" renewal, stock, lock, and barrel. Where a system is a very large one, it would appear unnecessary to have any such fund at all, more especially if the different parts making up the system were of different ages; for the average maintenance charges, or "partial" renewals, would be sufficient in such a case to cover the average "total" renewals on the many miles of line, and on the many power-stations and sub-stations of various ages. On the other hand, on a small system, all put down within a short time, the whole would become practically useless after a certain lapse of time, and all together; here a "total" renewal fund would be necessary. Again, it does not appear clear, in most of the proposed forms of accounts, that any provision is made for drawing on the various funds as occasion or necessity arises.

This question was answered by a street railway company in the United States in reply to the Street Railway Accountants Association, of America, in the

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following terms: "The books of a street railway company should show the value of the property, not its original cost. The amount representing its cost should not be reduced, but a 'Depreciation Reserve Account' should be opened, and the proportionate decreasing life, or depreciation, should be charged monthly, in 'Operating Expenses,' and credited to the 'Depreciation Reserve Account.' As the cost of the property represents the investment of the company's capital, the amount of such cost, as shown on the books, should not be reduced, and when the property is renewed or replaced, the cost of such renewal or replacement should be charged to 'Depreciation Reserve Account.'"

On the whole it would seem that the simplest way would be to set apart a certain percentage of the profits per car mile to cover the three items of sinking fund charges, depreciation, and "total" renewals, such percentage to be fixed in each particular case by a body of experts, who, in coming to a conclusion, would take into consideration the particular circumstances governing each such particular case.

The reserve fund may be looked upon as a kind of insurance fund against obsolescence and other quasi-accidental events, which might, perhaps, be taken up by some general company accustomed to dealing with risks of all kinds.

Another important point, which does not seem to have received the attention it deserves, is that of stores and materials in hand. Of course if the re-valuation, to which allusion has been made above, were to take place from time to time, the value of any stores or materials in hand would be taken into account. If not, they should certainly appear somewhere. Take for instance, the case of rails; a prudent manager would buy these whenever the market was favourable, and would always keep a sufficient stock of them in hand so as not to be forced to procure them *nolens volens*, at an unpropitious moment. The same is true of many other stores, of which large quantities are bought from time to time, and which are only used up very gradually.

The above are one or two points of principle which, if they could be settled by international agreement, would go far towards uniformity in general heads, to be naturally followed, in course of time, by uniformity throughout. Such international agreement could be come to very easily, as the three or four associations which cover the whole ground could, even by correspondence only, arrive at conclusions which would enable the accounts of similar undertakings all over the world to be drawn up in the same forms, and thus enable those useful comparisons to be made, which form the essence of all true progress.

E.B.

TRAMWAY MUNICIPALISATION QUESTION IN CHICAGO.

GLASGOW MANAGER ASKED TO VISIT AND ADVISE.

At a meeting of the Corporation of Glasgow on April 6, Sir John Ure Primrose, the Lord Provost, informed the Council that he had received the following telegram from Chicago: "Chicago, the first great city in America following the lead of Glasgow, declares for municipalisation of street cars by 25,000 majority. Will you give the manager of your municipal tramways a vacation of 30 days to visit Chicago to confer with me? All expenses, first-class travelling and hotel bills, will be paid by me. Answer.—Edward F. Dunn."

Mr. Hugh Alexander, chairman of the Tramways Committee, said he hoped the Council would unanimously agree to the request preferred by the Mayor of Chicago. He thought it was a great honour which had been paid to Glasgow. It was pleasing to find that America was at last coming back to follow the lead of the old country. He did not see any special difficulty in arranging to run along for a few weeks without the manager. The motion was unanimously agreed to.

The announcement that such an invitation had been received by Glasgow has awakened wide-spead interest in the tramway field in this country, indicating, as it does, that in the United States there is a growing disposition to consider seriously the question of the municipal ownership and operation of tramways, and a recognition that it is to Great Britain any inquirer must look for the best object lessons in such matters.

In the inception and development of electric tramways, Glasgow was very closely in touch with America —more so, perhaps, than any other town in this country. The most improved methods known in America were closely studied and largely adopted, so that on the engineering side the Glasgow system owes much of its success to America. Hence the invitation to the Glasgow general manager, Mr. Dalrymple, to give advice in Chicago on the subject of municipal ownership appears to be only natural. Such a request would, however, never have been made had it not been for the conspicuous success of the Glasgow system, from the points of view of management and finance. For success in these directions Glasgow owes no debt to America, but owes it to the sagacity and business acumen of her own citizens. This applies to the majority in the Corporation who, of course, have always the final say; to the Tramways Committee, and particularly to Mr. Walter Paton, who was for so many years chairman of the committee; to Mr. John Young, who, as general manager, developed the whole traffic and working arrangements; and to Mr. James Dalrymple who, as assistant manager and accountant and now as general manager, has borne a heavy share of the work.

The question of the wisdom of municipal ownership in American cities is another and a difficult one. It is beset by difficulties unknown in this country, the nature of which need not be particularised, as they are well known. The fact remains, however, that at the recent mayoral election in Chicago the candidate pledged to municipal ownership was returned by a large majority. Whether he will be able to carry the City Council with him, and if so whether he will stop at municipal ownership with leasing to a company, or will go in for direct municipal operation as well, remain to be seen. The latter course is indicated by the invitation to Mr. Dalrymple. To buy up the properties of the existing street railway companies in Chicago will involve an enormous expenditure, and this will be greatly enhanced if the Municipality proceed with the scheme which they have long been considering for the construction of a large system of underground electric railways in the more central districts. The great financial interests connected with American street railway companies are strongly opposed to municipalisation proposals, and if the latter are ultimately carried, it will probably only be after prolonged struggle and costly litigation. These things apart, however, the interest remains unabated in the fact that Mr. Dalrymple should have been chosen to go over to Chicago to show the Municipality "how to do it," so far as civic organisation is concerned.

Mr. Dalrymple sails for America on May 20. The New York correspondent of the *Glasgow Herald* contributed to that paper of May 1 a long article consisting of a semi-humorous description on the terrors of the interviewer and the opposition of American capitalists to municipal tramway ownership, which they denounce as socialism.

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MOTOR OMNIBUSES IN THE WEST OF ENGLAND

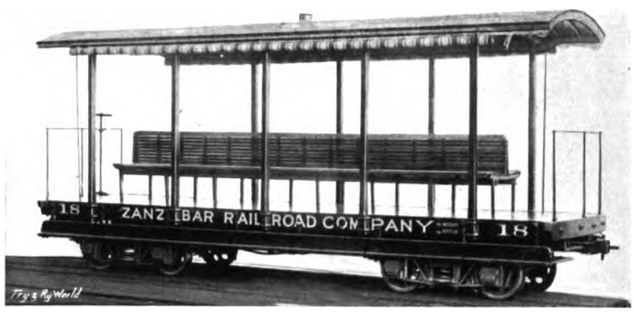
Clarkson's steam omnibus, of which an illustrated description appeared in our issue of March 9 last, is very favourably regarded by the Great Western Railway Company, and this was exemplified on April 6, by the Company inaugurating a service of these motor 'buses, between Cheddar and Burnham, a distance of 14 miles. Quite a ceremony marked the occasion, and there were in attendance a number of the railway company's officials from Bristol, Exeter, and other places, as well as of local authorities in the district. A highly successful trial trip with three 'buses was made. The vehicles are single-deckers so far as passengers are concerned, but they have been built so as to carry a large quantity of luggage on the roof. The seating accommodation is for 19 passengers, and the weight of the vehicle is 2¼ tons. Each 'bus is fitted with the boiler and engines made by Messrs. Clarkson, Limited, Chelmsford, the engine being of 18 H.P. The route lies through the picturesque Cheddar Valley, and for the most part it is almost level, the gradients being neither numerous nor steep. In the towns and villages along the route there is a considerable population, and it is hoped that the omnibus service will be the means of opening up a beautiful district for tourists. The 14 miles on the occasion of the trial trip were covered in about an hour and a half. The service in the meantime consists of four trips in each direction per day.

A luncheon was given at Burnham, when Mr. C. Kislingburg, Bristol dlvisional superintendent of the Great Western Railway, occupied the chair. In a speech which he made he gave some interesting particulars about the undertaking. He said that a few years ago an application was made to the Light Railway Commissioners for an Order to build a light railway from Cheddar to Highbridge. That scheme had the sympathy and support of the Great Western Railway Company, because they felt that the district was entirely shut off from railway communication, and that the scheme would be a success. The Order was never given effect to for some reason. Since the Order was obtained, rail and road motors had come very prominently to the front, and there was a difficulty in meeting applications coming from all parts of the country for rail and road motor services. Some of those applications were very reasonable; others were somewhat absurd. After a proper survey had been made of the district between Cheddar and Highbridge and Burnham there was no hesitation in coming to the conclusion that the district was well laid out for a road motor service. He was very glad they were on the eve of introducing such a service, which he hoped would prove very satisfactory to the district. It would rest entirely with the residents whether that service was augmented or not. The company only wanted their patronage. He should tell them that the service would not, and must not, be regarded as an experimental one. The service had come into the district to stop there.

JOHNSON AND PHILLIPS' CABLES.—Owing to the rise in the price of copper and rubber, Messrs. Johnson and Phillips, of Old Charlton, Kent, have had to make alterations in their price list No. 11, of which we have been favoured with a copy. The various classes of vulcanised cables are fully illustrated and described, and they are manufactured in strict accordance with the general rules of the Inst.E.E., of the Cable Makers' Association, and of the principal fire insurance offices. Every cable previous to despatch is tested, and a label is attached giving the result as follows, after stating the size of conductor, insulation class, and length in yards: "After 24 hours' immersion in water, this coil was found to have a minimum insulation resistance at the rate of — megohms per mile at 60 deg. Fahr." The testing rooms are fitted with transformers capable of working up to 20,000 volts.

INTERESTING CARS FOR ZANZIBAR.

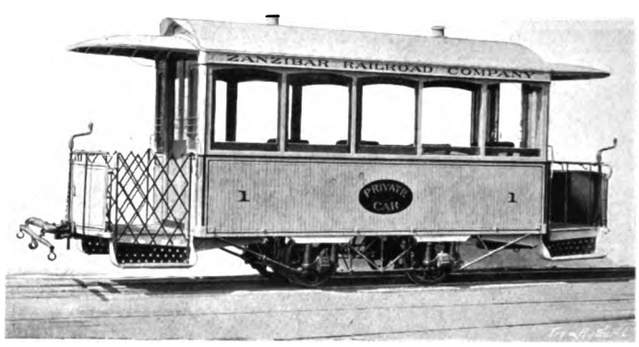
An interesting shipment of cars to the Zanzibar Railroad Company has just been made by the J. G. Brill Company, of Philadelphia, U.S.A., and consists of ten open double-truck cars, eight open single-truck cars and two closed cars designated "private." Although exceedingly simple



Double-Truck Car for Steam Traction.

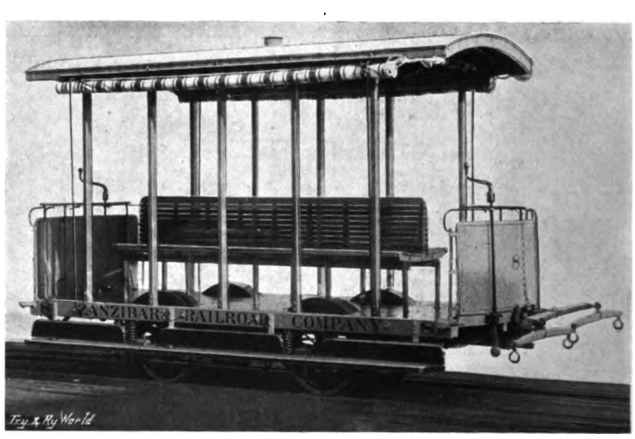
in design, the cars are substantially built and are admirably adapted to a form of service which does not warrant expensive equipment.

The ten double-truck cars are for use with steam dummies, and the eight cars on gear trucks will be drawn by horses. The double-truck cars measure 22 ft. over the crown pieces and are 5 ft. over the sills. The roofs are simply constructed and arranged to be readily removed,



Closed Private Car.

and the seats are also removable. The cars are mounted on freight trucks of the builders' manufacture. The weight of the car and the trucks is 8770 lb. The length of the short cars is 13 ft. 8 in over the crown pieces, and width over the posts, 5 ft. The curtains of both styles of open cars are arranged to be raised or lowered from one end by means of ropes with pulleys. These cars are mounted on Brill gear



Open Single-Truck Car.

trucks with 6 ft. wheel-base. The "private" closed cars are 14 ft. over the end panels, 21 ft. over the crown pieces, and 5 ft. wide over posts at belt. There are five windows to each side, arranged to drop into wall pockets. The interiors are finished in cherry and ash of natural colour, and the ceilings have carline finish. The cars are furnished with wicker chairs and the floors are covered with carpet rugs. They are also mounted on Brill gear trucks with 6 ft. wheel-base.

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NEW TYPE OF JOHNSON-LUNDELL DIRECT-CURRENT ELECTRIC MOTORS.

A new motor capable of almost universal application, and embodying some novel features as well as the teachings of more than a score of years of practical experience in motor designing and manufacturing, is being put on the market by the Johnson-Lundell Electric Traction Company, Limited, who have erected and equipped an up-to-date factory at Southall, Middlesex, for this purpose. The chief aim in the design of the motor has been to secure the small dimensions demanded where motors are used for direct driving, more particularly where the motor becomes an integral part of the driven machine. This condition applies in the cases of railways, tramways, automobiles, hoists, pumping and mining machinery, and machine tools.

In all these applications, available space and permissive weight are more or less determining factors, but speed regulation and quality of performance are factors that have received special attention and have been highly developed.

In the matter of speed regulation, the increasing practice of operating machine tools with an individual motor has developed a demand for a wide range of speed changes without sacrifice of efficiency, while the rapidity with which modern tools are made to do their work since the introduction of high grade tool steel has made it more or less necessary that these speed changes shall be quickly made. Moreover, the uniform performance demanded of automatically operating machine tools of a like character and purpose has imposed upon the individualized power a requirement of like performance in all machines of a like rating of an exceedingly exacting character. The way in which these several demands have been met in the new motors is the basis of the claim that they constitute a class by themselves.

The reduction of dimensions and weight has been effected mainly by the employment of a superior quality of metal for the magnetic field. It is of course well-known that wrought metal is superior to cast for this purpose, but the higher manufacturing cost and lower structural rigidity attendant upon the form of construction hitherto involved in the use of the superior metal has restricted its employment to the more imperative requirements of alternating current apparatus. It is claimed that these obstacles to its use in direct-current apparatus have now been effectually removed by the invention of a structural design of an ingenious character.

In this design the frame assumes the form of a skeleton grill or crate, which, though embracing the laminated metal constituting the field magnetic, does not in the least rely upon it for structural completeness, nor does the magnetic circuit require for its completeness any assistance from the enclosing frame. Each is complete in itself.

The two functions of the motor thus become so far disassociated as to permit of each being provided for in practical disregard of the other; obviously the magnetizing and mechanical factors may thus be obtained with a minimum quantity of the material of which they are respectively composed.

In these circumstances the laminations comprising the field become simple concentric rings, which are punched from the best quality of charcoal iron or mild steel and left entirely free of holes, bolts, or rivets, while the frame becomes a mere skeleton body so designed as to embrace the rings only at their unimportant diameters, thus limiting the important motor diameters to the actual requirement of the field magnet.

The gains incidental to this independence of the motor components are three-fold: (1) Superior mechanical strength and rigidity; (2) an unobstructed magnetic circuit; (3) a minimum use of the high-priced magnetic metal. The design of the crate or frame is such as to require the minimum of machine tooling, and manifestly the field magnet components, coming as they do complete from the punch presses, require none; hence the cost of manufacture is reduced to a minimum.

A minor feature that will strongly commend the design to all those who have the planning of new motor applications is the ease and inexpensiveness with which the motor supports may be modified to suit new conditions.

In the matter of speed regulation the motors are divided into three classes: (1) The ordinary variable speed series motor: (2) the regulation standard single speed shunt motor: (3) a new shunt standard having a speed change ratio of 3 to 1 on field regulation alone. In each of these classes the factors of dimensions, weight, uniform performance, cool running, sparkless commutation, etc., are all very highly developed.

In addition to the superior uniformity and quick-speed change capacity afforded by the laminated field magnets, these motors are given superior commutating properties through the agency of yet another novel improvement. This takes the form of a new type of commutating brush. As is well-known the two brush functions, collecting the current and promoting sparkless commutation, are quite antagonistic; hence their performance by a single brush unit has always been more or less unsatisfactory.

In the treatment of this detail of motor construction there is again, as in the case of the magneto-mechanical factors, a divorce of functional duties. Each of the brush functions is dealt with as though the other was practically non-existent. The new brush, instead of employing a common unit for current collecting and commutating, employs a sectionally divided one, with its sections arranged fore and aft in the direction of armature rotation; the forward section is composed of a high grade of soft carbon effecting a low resistance contact, and has the single duty of collecting the current. The after section, following literally on the heel of the other, is composed of hard carbon and effects a high resistance contact, and has the special duty of minimizing the commutating arc.

An additional and incidental gain attendant upon the sectional division of the brush unit is the practical impossibility of a simultaneous loss of contact from slight commutator inequalities; should these exist they must necessarily thrust the two sections from the commutator surface in sequence, thus preventing any actual circuit interruption and consequent arcing.

This improvement in commutation and current collecting results in two important gains: (1) a capacity to operate in a weaker field, and a consequent widening of the range of field regulation; (2) the superior wear of the commutator and brushes.

The Johnson-Lundell Company prefer to designate their changeable speed class as multi-speed rather than variable-speed motors, since the shunt characteristic, maintaining a constant speed regardless of the load, is in no way diminished. The fact that their speed may be changed from one fixed value, to another equally fixed, by a change of field strength certainly does not endow them with a variable-speed characteristic; that characteristic is the fundamental basis of the series motor, and to employ it in designating a shunt motor is a misnomer which must inevitably lead to confusion.

Therefore, since the new motors are characterized by a multiplicity of fixed speeds, they are more accurately designated as multi-speed; obviously consistent nomenclature requires that the single-speed type shall be designated as the uni-speed.

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THE PRODUCTION OF ELECTRICAL POWER.

CONCLUSION.

Amongst the accessory appliances in use in a power-station secondary batteries or accumulators claim some attention because of their importance.

Accumulators are made of lead grids, filled in with oxides of lead. These are immersed in dilute sulphuric acid. When a current from a dynamo or a battery is passed through the accumulator cell some of the water may be considered, for all practical purposes, to be electrolysed or split up into its components, hydrogen and oxygen. The oxygen appears at the anode or the plate of the cell at which the current enters, the hydrogen at the cathode or the plate by which the current leaves the cell. Now the hydrogen liberated at the cathode attacks the lead oxide and takes some of its oxygen from it to form water, and leaves the equivalent amount of lead on the cathode. The longer the current is continued the greater is the amount of oxide reduced to lead. This action, however, does not go on until all the oxide on the cathode is reduced, as the surface is acted on first, and the lead forms an outer coating which to some extent protects the inner portions. The oxygen at the anode acts on any oxide on this plate, converting it into lead peroxide, a dark brown substance containing more oxygen than the other oxides of lead.

If the connections at the terminals of the cell are now reversed so that the current flows through the cell in the opposite direction, hydrogen is produced at the plate which previously was the anode, but which has now become the cathode. The hydrogen attacks the peroxide of lead, taking its oxygen and reducing it to metallic lead. This lead, thus produced, is in a very porous or spongy state. The oxygen liberated at the plate which was formerly the cathode, but now the anode, attacks the lead formed previously, and it does this the more readily owing to its spongy state. Lead peroxide is formed as before described. This process may be repeated and each time the action goes further, until the cells are in a condition such that the action can go no further. The plates are then said to be fully formed. In the acid we then have two different plates, one of which may be regarded as lead and the other as lead peroxide, and these plates are necessarily at different potentials because of the different action of the acid on them. On connecting the terminals to a voltmeter, we find that there is a difference of somewhat over two volts between them. Hence if we connect them by a wire they will give rise to a current just in the same way as a primary battery. The current will flow for a considerable time, provided too great a current is not taken from the cell. The voltage of the cell keeps up remarkably well, but of necessity there is a decrease as the action goes on, for the lead is gradually oxidised and the lead peroxide reduced.

The current produced by the cell leaves by the brown lead peroxide plate. This is, therefore, termed the positive terminal, or pole, of the cell, and is usually painted red. When the voltage has fallen to 1·9 or thereabouts the current should be stopped and the cell recharged by sending in a current at the positive terminal, thus again producing lead peroxide at the positive plate. In this way the cell can be recharged and used over and over again, and, in a certain sense, we can speak of these secondary cells as accumulators, for we charge them by means of an electric current, and we can then take a current from them when we wish. The explanation just given of the chemical action taking place in the cell must not, however, be taken as being complete. As a matter of fact the action is very complicated, persulphuric acid, persulphates of lead, and other substances being formed. The above, however, gives a general idea of what is taking place. The cells used in the power-station each contain a number of plates, but these are connected together in such a way that they really form two large plates for each cell. These cells possess many advantages in addition to their capability of being recharged: they give a comparatively constant voltage, and have a very low resistance, so that very little energy is wasted in the cells themselves. Great care must, however, be taken in using them, otherwise they are soon spoiled.

In practical use in the power-station we may explain their usefulness by saying that they are used to equalise the loads on the dynamos. Both dynamos and steam engines work most efficiently when the load on them is constant. Now, on a tramway system sometimes the current required is much smaller than at others. At such times the energy given by the dynamo is utilised for charging the accumulators. The dynamo and battery are connected up so that this is done automatically. At other times, say when a considerable number of cars happen to start at the same time, a sudden load is thrown on the dynamo, but if this is connected up with the battery the latter takes part of the load. In this way the battery acts as a kind of a buffer to the dynamo, and consequently to the engine also, for if the load on the dynamo is kept fairly steady the power required from the engine and boilers remains steady also.

In some cases a battery of accumulators is used for working a tramway system during some parts of the day. This method has been adopted in some combined electric lighting and traction power-stations where the dynamos are used during the daytime to work the cars and charge the batteries, while at night the dynamos are used for lighting and the battery for working the tramways.

In many power-stations are now to be found small machines, known as boosters. A booster is practically a motor and dynamo combined. It is used for modifying the drop in voltage on the feeders of a tramway system, or on the track which is used as the return conductor. When the booster is working one of its terminals is at a higher potential than the other, and this potential difference may be made to have any value required according to the winding of the machine and the speed at which the armature rotates. If it is required to raise or lower the difference in potential at two points on the circuit, this can be done by connecting the two points to the two terminals of the booster.

Boosters are also frequently used for charging the accummulators instead of connecting them direct to the dynamo. When used for this purpose they are called milking boosters. This name seems to have been given to them because when the battery is almost fully charged the gases liberated escape through the liquid, making the liquid appear white and semi-transparent or milky.

Leaving now the various machines and separate appliances used in a tramway system let us now consider the transformation of energy which takes place in a tramway installation considered as a whole. The energy is derived from the coal supplied to the boiler furnaces. The combined efficiency of the best of modern boilers and engines is unfortunately very low. A good plant requires about two pounds of coal per hour for each indicated horse-power. One horse-power = 33,000 foot-pounds per minute and this equals 1,980,000 foot-pounds per hour. One unit of heat is equal to 778 foot-pounds of work, and therefore, one horse-power = 1,980,000 ÷ 778 or roughly 2,550 heat units per hour.

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Now one pound of good coal will produce 12,500 to 14,000 heat units and two pounds say 28,000 heat units at the most. The engine only gives out approximately 2,550 units or somewhat less than ten per cent. of the energy supplied, that is to say roughly ninety per cent. of the heat is wasted in the boiler house and in the engine. How and where do these losses occur? Careful experiment gives us the following approximate figures in answer. Representing the total heat given out by the coal by 100 we find—

Lost through radiation:		
(*a*) From boiler	5·0	
(*b*) From large steam pipes	1·6	
(*c*) From small steam pipes	·2	
(*d*) From engine..	2·0	
		8·8
Lost in ashes		1·0
Lost in gases escaping from chimney		22·0
Lost in pump and other exhausts		1·5
Rejected to condenser		57·2
Converted into work..		9·5
		100·0

Evidently the greatest losses occur in the condenser and in the chimney gases. A good economiser will reclaim a part of the heat from the chimney gases, and some of the heat given to the condenser can also be utilised, but even then the loss is enormous, and up to the present time no method of considerably reducing the loss seems to have been proposed.

Compared with the efficiency of the steam plant, the efficiency of the electrical plant is very high. Taking ten per cent as the amount of heat converted into work as shewn by the engine indicator, the energy delivered at the fly wheel of the engine will be about 9·5 per cent. in a very good engine A good dynamo has an efficiency of about 96 per cent., so that the energy given up by the dynamo will be 9·5 × ·96 = 9·12 per cent. of energy contained in the coal. The energy lost in the feeders in transmission, of course, varies considerably according to size and length, but may be taken on the average as about 10 per cent., so that 9·12 — ·91, or 8·21 per cent. reaches the motors of the cars. The efficiency of the motors depends largely on the speed, varying from about 90 per cent on top speed to about 60 per cent. at low speed. Hence the amount of energy available for traction purposes is only from 4·9 to 7·3 per cent. of the energy supplied in the coal, and in many cases is much less than this.

Having now reviewed the main appliances employed on a tramway system, we bring these articles to a close, and if we have been the means of helping any readers connected with power-station work in any capacity, and have stimulated them to a study of electrical matters, fuller information on which they will find in the standard books on the subject, we shall consider the object with which we started these articles achieved.

TRAMCAR FENDER TESTS.—Eighteen different types of car fenders have recently been tested by the Vienna tramway authorities. According to the *Elektrische Bahnen & Betriebe*, dummies of about the same shape and weight as an average human being were successively placed on the track in upright and recumbent positions. The tramcars advanced at a speed of from about 6 to 9½ miles an hour, the brakes being put on two yards before the dummies were struck. The trials were disappointing, and no device could prevent the dummies being damaged. The trials are to be continued.

TRAMWAYS *v.* MOTOR 'BUSES.—At the monthly meeting of the Chester Town Council, the Tramways Committee submitted reports by the electrical engineer, city surveyor, and the tramways manager, on the proposal to utilise motor-'bus traction for the Boughton route. All these officials being in favour of electric tramways, the Committee proposed to carry out their original intention of constructing a tramway through Boughton The Council adopted the Committee's recommendation by a large majority. A motion that the Council should purchase three motor 'buses was defeated.

EXTENSION OF THE LONDON UNITED TRAMWAYS.

The work of constructing the fifteen route miles of electric tramways in Surrey, forming an extension of the existing tramway system of the London United Tramways Company in Middlesex, was formally commenced on April 3, a start being made in Kingston Road, New Malden. Mr. J. Clifton Robinson, C.E., the managing director of the London United Tramways Company, was present, as well as the Mayor of Kingston-on-Thames (Mr. H. C. Minnit) and Mr. A. Streeter (the chairman of the Malden and Coombe Urban District Council) and members and officials of local authorities. Mr. Clifton Robinson, having addressed the assembly, giving a brief description of the scheme, the ceremony of wielding the first pickaxe was performed by the Mayor of Kingston, and about 400 navvies were speedily employed digging up the road. The contractors for the extension of the London United Tramways are Messrs. J. G. White and Company. Further particulars in regard to the work were given in our issue of April 6.

LIGHT RAILWAY COMMISSION.

The Light Railway Commissioners resumed their inquiry in London on April 10 respecting the Headcorn and Maidstone Junction Light Railway which stood adjourned at Maidstone on March 17, and after sitting from 11-15 to 5-30 again adjourned the inquiry. On April 10 the Commissioners issued their draft Bath Electric Tramways (Light Railway extensions) Order, 1905. The Commissioners held an inquiry at Carnarvon on April 15 into the application of the Portmadoc, Beddgelert, and South Snowdon Railway Company for the conversion of two sections of their scheme into a light railway. The secretary to the National Trust, Mr. Bond, opposed the proposal to reduce the length of the tunnel into the pass of Aberglasglyn from 700 to 224 yards. The representatives of the railway company said that they took quite as much interest as Mr. Bond in the protection of the scenery, and they proposed to do everything reasonable to screen the railway from view The Commissioners granted the application, but deferred their decision on the objection raised by the National Trust.

The Commissioners have recently forwarded the following orders to the Board of Trade for confirmation: East Sussex Light Railway (Amendment) Order, 1905, amending the East Sussex Light Railway Order, 1901 (April 19.) Woking and Bagshot Light Railways Order, 1905, authorising the construction of light railways in the Urban District of Woking and in the rural district of Chertsey, in the county of Surrey (April 19). Maidstone Corporation Light Railways (Extensions) Order, 1905, authorising the construction of light railways in the borough of Maidstone and in the rural district of Maidstone, and on the boundary of the rural district of Hollingbourne in the county of Kent (April 20.) Priston Light Railway Order, 1905 (formerly under the title of North Somerset Light Railway), authorising the construction of a light railway in the county of Somerset from Priston to Dunkerton (April 25.)

On April 20 the Commissioners issued their decision on the application of the Portmadoc, Beddgelert, and South Snowdon Railway Company, for an order to authorise the company to reconstruct, construct, and work their authorised railways as a light railway, in respect of which the Commissioners held a local inquiry at Carnarvon on April 15. The Commissioners state that they are prepared to make an order enabling the company to construct as light railways the railways now authorised by Acts of Parliament of 1901 and 1904, and to work them under the Light Railways Act of 1896, as one system with the company's light railways to be authorised between Beddgelert and Bettws-y-coed, and with the undertaking of the North Wales Narrow Gauge Railway Company between Beddgelert and Dinas. The Commissioners have also decided that the modifications of Section 19 of the Act of 1901, as proposed by the company (*i.e.*, reducing the length of the tunnel through the pass of Aberglaslyn) should be included in their order for the construction of the railway under the Light Railways Act, 1896.

The Commissioners on April 27 resumed and finished their inquiry respecting the Headcorn and Maidstone Light Railway, but did not give any decision.

RADCLIFFE TRAMWAYS.—The tramway between Radcliffe Bridge and Little Lever boundry was opened on April 18.

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FARES ON BELFAST CITY TRAMWAYS.*

By Andrew Nance
(General Manager of Belfast City Tramways).

The chief objects to be sought, in any decision upon the question of fares, are:

1.—That they may be readily and accurately understood by passengers, especially strangers to the city.
2.—That the ticket issue and checking, as well as the duties of the conductors on the cars, and the clerks in the office, may be reduced to a minimum, and simplified as far as possible.
3.—That any chance of difference of opinion, or doubt as to the proper fare, may be eliminated.
4.—That the fare decided upon may have the elements of finality.
5.—That the fare may be reasonably expected to produce, for every car-mile run, on an average of the day's run of each car, a sufficient number of pence, over and above working expenses, to show a satisfactory and sufficient profit.

In my opinion, there are "four" systems of fares, which are applicable to the special conditions of the Belfast tramway system, and I propose to consider them *seriatim*. They are:

A.—Universal Penny Fare;
B.—The Present Scale of Fares;
C.—Penny from Castle Junction out;
D.—Halfpenny Fares.

A.—Universal Penny Fare.

It is necessary to explain, that a universal penny fare means, that a passenger, for one penny, can travel as far as he or she likes in the car on which the fare was paid. It allows no transfer; so that a passenger, wishing to go right across the city, would have to change cars at Castle Junction, if the car, on which he paid his fare, was not going to the destination required; he would have to take another car there, and pay another penny. No other fare would be taken on the tramcars, except a penny fare, with the exception of the children's halfpenny fares, which would be available on the same conditions as at present. It will be observed that it is an "average" fare, and that an essential feature is that no higher or lower fare can be accepted. Persons using the cars would have to consider all the journeys they will be likely to take in any year, and decide, whether the long journeys they take will not amply compensate for any short journeys they may have indulged in. Even with respect to these short journeys, they would pay no more than they do now—namely, one penny.

The machinery of collecting and accounting for the receipts of the undertaking, whether it affects inspectors, clerks, or conductors, will, by this system, be simplicity itself. It will also be extremely easy for citizens and visitors to understand. With the more rapid progress of electric cars, persons living almost anywhere in the city will be enabled to go home in the middle of the day to their meals, for the small sum of twopence (return), without consuming more time than they are able to allow themselves. I have always been much struck by the care people take to get houses within the penny stage. This fare will enable numbers of them to live on the higher and healthier ground in the outer area of the city; and incidentally give a vigorous start to building in the outskirts, thus causing a quantity of vacant ground to be developed, and giving a much needed impetus to the building trade. Every car, also, will then become a workmen's car; and, not only will artisans, etc., be relieved of riding in a car specially labelled "Workmen's Car," but they will be able to get a car, wherever they may be working, for the statutory penny, and at any time they want it. I believe, also, that a great many working-men will go home to a mid-day meal; and I am sure that that will be better than spoiling their digestions with the roughly-made tea and uncomfortable meal many of them are obliged now to put up with.

I am, in the first place, dealing with the "general" effects of a universal penny fare, and those I have hitherto stated are all in its favour. I must confess that I am unable to state any material disadvantages. Of course, it may be urged, that only from 10 to 15 per cent. of the passengers live in the outer area, and that it will principally benefit these persons. The answer to that is, that none of the others will pay more than a penny, which is the minimum fare at present. I may also be permitted to add, that it is generally conceded, in the interest of the health of the inhabitants of large towns and cities, and for many other considerations, that the wider you can distribute them over the municipal area, the better it is; therefore the long-distance passengers should be distinctly encouraged.

I shall now attempt to prove to the committee that the universal penny stage is economically sound. Unfortunately I have only one "large" system to point to which has adopted this kind of fare; but it is enough for my purpose. I allude to the town of Hull. This system has been in operation by the Corporation for the past six years, and, from the first, it adopted a universal penny fare. Unlike the Belfast system, which has for twenty years earned a substantial profit, paying as much as 7½ per cent. to its shareholders, the Hull tramways, under company management, ruined company after company. Presumably on account of its favourable fare system, it has been a uniformly increasing success, ever since the Corporation began to work it; and last year it paid £19,500 to the relief of the rates, besides putting aside an ample sum for depreciation. The Mayor of Hull (who is also chairman of the Tramway Committee), Alderman Larard, J.P., speaking on March 9, 1905, said: "They had carried out the law which said that no fare should be less than one penny. He thoroughly believed in the universal penny system, and thought it had been one of the greatest factors in connection with the success of the Hull tramways. (Hear, hear.) In Hull they gave the biggest pennyworth of any other place in the kingdom. . . Leeds had been cited, but Leeds was not doing as much for the tramway system as they were." On the same day Alderman Sir Alfred Gelder, a member of Hull Tramway Committee, said: "The tram service has made a surplus. He thought it was a legitimate surplus, and one that they might be proud of, having regard to the fact that they had made more than probably any other municipality." It only remains to add that the population of Hull is 250,000, against Belfast's 350,000. It is clear, therefore, that the universal penny fare is a complete and acknowledged success in Hull. I may add, here, that the tramway undertaking most like Belfast is the admirably-managed system of the City of Leeds. It is a "star" system, with a junction in the centre of the city traversed by all cars. The population is about 450,000. Their annual car mileage is 6,000,000, comparing with 4,750,000, which I propose to start with, when the electric service of Belfast is complete. Leeds contributed last year £52,000 to the relief of the rates. The tramways have been worked by the Corporation for nearly eight years.

I now wish to estimate the result of applying this system of fare to Belfast. The company in the year 1904 carried 27,472,336 passengers, at an average fare of 1·14 of a penny. They carried "ten" passengers per car-mile run. The result of the adoption of a universal penny fare will be the apparent loss of 0·14d. per passenger. I am of opinion that this will be made up in two ways:

(1) I think that at least 10 per cent. more passengers will ride in the cars on account of the change of fare; numbers of people will go home to meals who cannot do so now; a great increase will arise on account of the people being able to take a long tram ride for twopence (return), who could not afford sixpence (return)—the present charge; many workmen will use the cars who cannot do so now, because no workmen's cars run to the place where they are employed; and there will be an increase, from the feeling on the part of people generally, that "*there* is the tram and the fare is only a penny."

(2) I think that the change to electric traction will, *per se*, cause an increase of 15 per cent. in the number of passengers. I include in this the passengers on the extensions of the present system now being constructed. This works out as follows. It is necessary to remember that, with this fare, the number of passengers and the number of pennies is the same:

1	
Passengers per car-mile carried by the company	10
Add as due to Universal Penny Fare, 10 per cent.	1
Add as due to electric traction, 15 per cent.	1½
Estimated passengers per car-mile	12½
2	
Pence per car-mile—same number as passengers	12½d.
Deduct working expenses	6
Gross profit per car-mile	6½d.
3	
Proposed annual car-mileage...	4,745,000
Multiply by gross profit	6½
Annual gross profit in pence	30,842,500d.
Do. do. in pounds	£128,510
Deduct interest and sinking fund £55,000	
Do. do. depreciation 23,510	
	78,510
Balance in relief of rates	£50,000

I am of opinion that this result can be reached in the second year of working, if there is no abnormal charge for repairs, which is not to be anticipated.

B.—The Present Scale of Fares.

The first objection to these fares is that the citizens of Belfast have undoubtedly expected, with confidence, that they will be materially reduced. If they are not there will be widespread disappointment, and this will be all the greater from the fact that the company, during its numerous negotiations with the Corporation, did on two occasions offer as part of its terms to establish a universal penny fare. I need not trouble the committee with any explanation as to how these fares will work. They have not been changed for the last 15 years, and are well known to all. I am of opinion that they would leave an annual sum available for the relief of rates of £25,000 within two years, after interest, sinking fund, and depreciation have been deducted from the gross profits.

* A Report to the Chairman and Members of the Tramways and Electricity Committee for the Belfast City Council.

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C.—Penny from Castle Junction Out.

This method has often been discussed with me, and it has many attractions until it is examined. Broadly, I may say that I am of opinion that, as compared with the present fares, it would result in a great part, if not all, of the twopenny fares being turned into penny fares; and I do not believe that much of this loss would come back. Then, the insuperable difficulty would arise as to how to deal with the passenger who wants to travel from a point 400 yards on one side of Castle Junction to a point 400 yards on the other side of it, say from the new Town Hall to the Albert Memorial. He would by this system have to pay twopence. This would at once produce a demand for an overlapping stage, say from Botanic Gardens to Mountpottinger or Carlisle Circus. Therefore it would end in reverting to the old system of stages, but so lengthened that it is doubtful if it would be possible to make both ends meet. Then again, the conductor would have to issue twopenny tickets as well as penny tickets. In fact, I am of opinion that it will be far better to retain the present stages, *if stages are to be retained at all.* The constant difficulty will be continued which the conductor now experiences with that class of passenger, who will not get out when his stage is completed, or who jumps on to the moving car when it is approaching any stopping place, in order to get the best of the ladies and other people who are waiting at the stage, and is indignant if he is charged as having ridden in the previous stage. These are the kind of troubles which it is desirable to avoid, and which frequently make it necessary to bring the offender before the magistrates. They would all disappear with the abolition of stages. I have found, when it is explained how few people take the threepenny tickets (only 185,000 passengers a year out of the 27,475,000 total passengers carried by the company), that its advocates are generally of opinion that there is no good reason for not adopting a universal penny fare at once. This system would, *anyhow*, cause the loss of one penny out of every threepenny fare. The universal penny fare will, therefore, only add another 185,000 pence a year to the loss, or about £770. There are also the twopenny passengers, who at present go from one side of the Junction to the other side. By the "*Penny from Castle Junction out,*" if kept at that, these people would still pay twopence. But, as I have said above, there is no doubt that an overlapping stage will be forced on the Corporation. So that I estimate the apparent loss by adopting the "*Universal Penny Fare*" instead of the "*Penny from Castle Junction out,*" to be only £770 a year, and the inducements for additional traffic, offered by the former, exist in a very small measure with respect to the latter.

D.—Halfpenny Fares.

I wish to say at once, that I am of opinion, that the adoption of halfpenny fares will mean that the undertaking will be worked at a considerable loss. I should like also to point out, that it is a complete delusion to suppose that halfpenny fares are of any use to working men. The longest halfpenny stage in the United Kingdom is that of the London County Council. It averages 1,155 yards, or not much over ⅝ of a mile. It is no use to a working man to be carried about half-a-mile. He prefers to walk "that." What he wants is a good, long ride for a penny in which his wife and children can share. I can show that these halfpenny fares are not used by the working men to any great extent. Mr. J. Young, who until recently managed the Glasgow Corporation Tramways, had observations taken not long ago to ascertain the class of persons who used halfpenny fares. I have not the reference by me, but I believe I am absolutely correct when I say from memory that the result was that 83 per cent. were rich and well-to-do people, and only 17 per cent. were working men, small shopkeepers, and people of humble means. I find that only eight municipal tramways have adopted halfpenny fares over their system out of fifty-five. These fares have not, even in London with its enormous traffic, been shown to be financially successful; and even in Glasgow and Sheffield, though they have undoubtedly increased the passengers, and possibly the revenue, there are still sceptics who doubt whether the game has been worth the candle. It must be remembered, too, that in all places where there are halfpenny stages there is a never-ceasing and growing demand for their extension, and there is a great danger that these demands may become in time irresistible. Then there is the certainty that the "short-distance" will crowd out the "long-distance" passenger, and there is absolutely no remedy for that. A lot of halfpenny people get into the car say at Castle Junction, ride their half mile, and get out; and then their seats remain vacant for the remaining 2½ miles of the journey, whereas there are long-distance passengers at the junction who have been crowded out, and who must wait until they can force their way into one of the cars. Another disadvantage is in the working of the cars. Halfpenny stages mean that there will be "six" different classes of fare—½d., 1d., 1½d., 2d., 2½d., and 3d. The poor conductor has to manage these six sorts of tickets in his hand, and twice on each half journey mark his way bill with six closing ticket numbers instead of one. The work of the clerks will be six times what it would be with the universal penny fare and will necessitate a material increase in the office staff; also the conductors will find it very difficult to remember to which of the six classes his passengers belong; and people, in consequence, will find it easy, if so disposed, to ride beyond their stages.

It is necessary that I should ask the Committee to consider, not only the working defects of this system, but, also, how it will economically affect the undertaking. About 85 per cent. of our present passengers are penny passengers. It may be safely assumed that 30 per cent. ride three-quarters of a mile or less, 30 per cent. ride about one mile, and 25 per cent. ride from one to one-and-a-half miles. Of course all of the first class will become halfpenny passengers. It may be also assumed that two-thirds of the second class will also make a halfpenny ride serve their purpose. So you turn about 50 per cent. of your passengers into halfpenny passengers. This means an annual loss in receipts of £28,620. To restore this, 13,750,000 new halfpenny passengers will be required, and I have grave doubts whether more than five millions could be counted upon, if so many. It is also to be remembered that this number of extra passengers would involve a considerable increase in the service, and an increase in the service would involve additional capital expenditure. In other words, there would be a loss in revenue and an increase in expenses.

Having regard to all these considerations, I respectfully, but strongly, represent to the committee my well-considered opinion, that the system of fares best suited to the needs and requirements of the City of Belfast is that known as the "*Universal Penny Fare*"; and, I may add, that my hopes of helping to make a material financial success of the Belfast Tramway Undertaking are in a great measure based upon the adoption of this system.

It may be some guide and interest to the committee if I add that I have before me the accounts of 54 municipal tramways for 1904. I find that nineteen made a deficit; twelve made a profit of less than £1,000; ten made a profit of over £10,000; and thirteen a profit of between £1,000 and £10,000. The following are the municipal tramways which made a contribution to the rates in 1904:

Leeds	£52,000
Manchester	50,000
Liverpool	32,081
Glasgow	25,000
Hull	19,500
Nottingham	13,000
Salford	12,000
Sheffield	7,950
Southampton	5,000
Sunderland	4,014
Bolton	2,261
Cardiff	642

THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

The official circular, as the monthly pamphlet of the Association is called, contains, as usual, a considerable amount of information, useful and interesting, not only to the members but to all those concerned in the undertakings from which it takes its name. From the letters that have passed between the secretary and the Local Government Board it would appear that the President is not very anxious to amend the present procedure in the rating of tramways, which is anything but satisfactory. Similarly, the Board of Trade write that they have nothing to add to their previous communication in which they expressed their inability to fall in with the view taken by the association that tramcars should not, without sufficient reason given, be subjected to greater disabilities than similar traffic.

A *precis* is given of the replies received from 131 tramway undertakings to questions on the subject of limiting liability in cases of accident to third parties travelling at less than the statutory fares. Only 15 tramways do this, of which six are worked by Corporations, the remainder by companies. The usual limit imposed is £25, and in most of the cases where the rule has been in force for some time the results have been satisfactory, as the number of claims and the amounts thereof have sensibly decreased. The legality or otherwise of the system, has, moreover, not yet been settled in any court of law.

In the paper read recently on "Friction as affected by Lubrication," Mr. W. F. Parish, the chief technical adviser to the Vacuum Oil Company, gives the results of exhaustive tests made by himself on different lubricants under various conditions—no less than 28 slides of diagrams and of machines used in taking them were exhibited. The variations in one mill at different times of day and under differing conditions as to temperature and moisture, not to mention lubricants of sorts, were surprising. The paper which is given in full is well worthy of careful study, and it was followed by a lively discussion which will be printed in the next circular.

Faraday House.—The new premises of the Electrical Standardising, Testing and Training Institution at 66-70, Southampton Row, W.C., was completed and ready for the reception of students for the summer term on May 1.

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FEEDERS AND RETURNS OF ELECTRIC TRAMWAY SYSTEMS.*

By H. E. Yerbury, A.M.I.E.E., A.M.I.Mech.E.

I purpose confining my remarks to tramway systems supplied with power from one generating station at 500 to 550 volts, as it is beyond the scope of one paper to adequately deal with multiphase distribution with direct-current sub-stations, multiple stations, battery sub-stations, and continuous-current systems.

Feeders.

It must be admitted that local conditions materially affect the general arrangements of feeders, and the most economical system is determined when such factors as gradients, density of traffic, permissible voltage drop, and load curves are taken into consideration.

In the early days of electric traction, economy was the primary consideration, and efficiency seemed to take second place, and it was not unusual to find that expenditure in copper was cut down to the lowest possible amount consistent with safety, and as the inevitable extensions were proceeded with it became apparent even to the general public that a considerable drop in voltage took place at the termini of tramway systems. It is recognised that a variation of voltage up to 10 per cent. does not materially affect the satisfactory working of a tramway system, and in the arrangement of feeders this 10 per cent. loss should determine the limit of economical and efficient distribution by continuous current from one generating station.

Where electrical energy is generated at a low cost (as for instance, Sheffield tramways works costs ·38d. per unit), the working radius from the power-station may be extended, for cheap power often compensates for increased distribution costs, and either heavier conductors may be used or positive boosters, but generally speaking, with or without boosters it is uneconomical to run a large service of cars a greater distance than 3½ to 4 miles from the source of direct current supply.

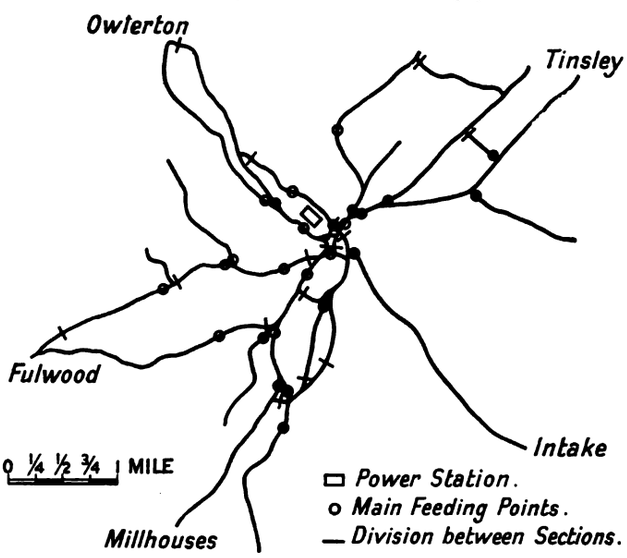

Fig. 1.

It must be borne in mind that power lost on mains and distributing feeders costs as much as power actually taken by motors on cars, and where boosters are used the annual capital and maintenance charges on boosters plus the energy taken to drive them, form a part of the distributing costs up to the trolley feeding points.

From information kindly furnished by 22 municipal engineers relative to their respective tramway undertakings, I find that the average current density on feeders up to 1½ miles in length amounts to 630 amperes per square inch, and on feeders above 1½ miles, 527 amperes per square inch under ordinary conditions of service, and the percentage of sectional area of returns to feeders on an average amounts to 81·5 per cent.

In the past too much value was placed upon the parallel circuits provided by the trolley wire, and as high resistance wire such as phono-electric, or phosphor-bronze is now largely used on account of lasting properties, it is not always advisable to consider the area of trolley wire of a given section as forming an equal relative proportion to the area or cross section of the feeders.

Taking an average from the above systems, there are 3,208 yards of double line fed from one positive feeder. In arranging a system of feeders and returns, allowance should be made for abnormally heavy loads such as occur during, say, a heavy fall of snow or exceptional traffic, and the product of amperes into miles is a simple and convenient method of calculating section of cable required, length of same and position on rails of return conductors. To comply with the Board of Trade requirements and to use as little copper as possible, and to waste as little energy as possible in distribution and returns, are the principal considerations.

The average length of positive feeders on nineteen large systems is 2,256 yards, and on return cables the average length is 1,419 yards. Where return cables are of this length, a considerable drop of voltage is bound to occur, and as the load on returns does not fluctuate to the same extent as on feeders, it follows that a much heavier loss is incurred under these conditions than would take place if the power-station was situated near the rails.

It is customary to divide trolley lines into separate sections, each section varying from one to three miles in length, being fed by a distinct feeder from the power-station. The load of each section can then be noted, and the system can be so arranged that all feeders work at approximately equal current density, and it is also advisable to feed trolley lines at both ends in order to minimise voltage drop and equalise the potential difference at section insulators.

The methods of feeding on nineteen of the largest systems are as follows:

Feeding at both ends	7
Feeding at one end only	3
Feeding at centre only	3
Feeding both ends and centre	4
Feeding one end only and centre	2

In the writer's opinion it is advisable to split up sections of line fed by a single feeder as much as possible in the centre of a large system, in order to facilitate the cutting out of feeders or overhead line in the event of a fault occurring.

In the early days of electric traction, fuses and automatic circuit breakers were placed in street feeder pillars. These were found to be a source of continual trouble, and it is now the usual practice to only have circuit breakers (apart from those on cars), on the switchboard at the power-station.

Figure 1 is a plan of the Sheffield Corporation tramway system, showing the feeding arrangements, and also the points where section insulators divide different lines fed by separate cables.

Returns.

The Board of Trade rules and regulations have undoubtedly a governing influence on the arrangement of return conductors, and it is found in practice that the limit of seven volts drop on rails can be easily complied with on any properly designed tramway system. The writer regrets that the prediction set forth, principally by theoretical experts in the early days of electric traction in England, as to possible and probable damage to gas and water pipes, still has a tendency to cause alarm to owners of such pipes, and in at least one instance great precautionary measures have been adopted, the case in point being the Sheffield United Gas Light Company, who succeeded in getting the following protective provision inserted in the Sheffield Corporation Act of 1901:

> "Notwithstanding anything contained in the said Acts of 1896, 1897, 1900, or this Act, if it be *proved* that any injury or damage to any mains, pipes, or apparatus of the Sheffield United Gas Company shall have resulted from fusion or electrolytic action caused by any currents generated or used for the purpose of electric traction on any tramways for the time being belonging to the Corporation, nothing in the said Acts or this Act shall relieve the Corporation from any liability to make compensation for such injury or damage which would have existed but for the passing of the said Acts and this Act."

The company asked the Corporation to give the usual undertaking to insert the clause in the bill, but this the Corporation declined to do, contending that the regulations of the Board of Trade were an ample protection to the company. The gas company petitioned against the bill, and a stiff fight resulted on the matter before a Parliamentary Committee of the House of Commons, which ultimately decided to give to the company the protective clause above mentioned.

I may say that efforts have been made by various companies to induce Parliamentary Committees to insert a similar protective clause in their interests in other bills of local authorities seeking powers to lay down tramways, but I believe that in no instance has a Parliamentary Committee given such a protective clause since such a clause was inserted in the Sheffield bill of 1901.

Since the passing of this Act, and up to the present time, a worthy and esteemed member of our profession is retained by the gas company, and every facility is afforded by the writer to this gentleman for periodical D.P. tests to be taken over our entire system, and I am happy to say that in no single instance has a higher D.P. been recorded than is allowed by the Board of Trade. Possibly in due course the company will realise that the theories relating to electrolytic troubles have been overrated, and that the real grievance, if any, should be directed to nature, or mother earth.

Fortunately, the Sheffield water department is under the control of the Corporation, otherwise interesting cases would undoubtedly be brought forward whenever a lead or cast-iron pipe had to be renewed

* Paper read before the Leeds Section of the Institute of Electrical Engineers, April 13, 1905.

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owing to pitting or corrosion caused by the nature of the soil in which such pipe was embedded.

The following analysis shows what effect has been produced by laying cast-iron pipes in soil largely composed of ashes from steel works in Sheffield.

After a period of two years one of these pipes burst, and when removed and broken up it had the appearance and hardness of plumbago. An analysis of this iron gave the following result:

Iron	36·60	per cent.
Silica	27·00	,,
Alumina	15·50	,,
Graphite	16·80	,,
Lime	1·20	,,
Oxygen, &c., by difference	2·90	,,
Total	100·00	,,

The writer has also seen lead pipes and cast-iron pipes pitted, and often holes eaten right through, such effect being undoubtedly caused by chemical action (and possibly galvanic) set up by the corrosive properties of the soil. Fig. 2 shows a piece of 9 in. cast-iron water main which was taken up in August, 1892, many years before electric tramways were started in Sheffield. These pipes were laid in 1875, and when taken up were in perfect condition except where in contact with the acid sub-soil.

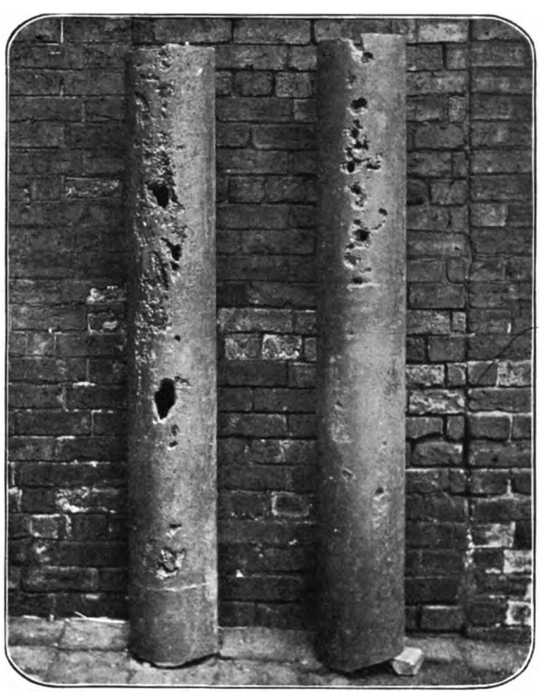

Fig. 2.

As grey forge pig iron is very extensively used for gas and water pipes and it contains a large amount of free graphitic carbon, in the writer's opinion this iron is more susceptible to pitting than what is known as white iron, which, owing to its hardness, is difficult to drill and cut, and for that reason is not used as extensively as the softer metal, although it undoubtedly lasts longer relatively, no matter what soil it is embedded in. The following is an average analysis of both metals:

STAVELEY GREY FORGE PIG IRON.

Iron by difference	91·88	per cent.
Combined carbon	0·56	,,
Graphitic carbon	2·90	,,
Manganese	0·81	,,
Silicon	2·34	,,
Sulphur	0·09	,,
Phosphorus	1·42	,,
	100·00	,,

STAVELEY WHITE IRON (slightly mottled in parts).

Iron by difference	92·90	per cent.
Combined carbon	3·10	,,
Graphitic carbon	0·90	,,
Manganese	1·01	,,
Silicon	0·45	,,
Sulphur	0·28	,,
Phosphorus	1·36	,,
	100·00	,,

In considering possible damage to water and gas pipes by earth currents, it is advisable to take into account the length of the tramway routes, inside which the rails are negative to earth and pipes, and to apply what might be called a theoretical rail potential curve.

In order to compare an ordinary rail return system with one having negative return conductors, from Fig. 3 we draw above the rails as abscissæ the D.P.'s which would correspond to the different parts of the rails, assuming no current escaped to the earth. Take the area enclosed by curve CDE and erect a rectangle of same area on CE. The height of this rectangle CF will then be equal to earth potential. The true earth potential is really not represented by the line FG owing to varying differences of potential on the rails which make the line to be approximately in the position indicated by the dotted line.

It will be seen that the theoretical D.P. is represented by a parabolic curve, whose apex D is situated at the end of the track. The equal areas indicated by positive and negative signs denote with the positive sign where rails are positive to the mass of earth, and in the negative sign where the mass of earth is positive to rails. "Y" may be taken to denote the neutral point on rails, and the negative booster cable should be connected to a point beyond the neutral, from one-half to two-thirds of the total distance from generating station or central return feeder point.

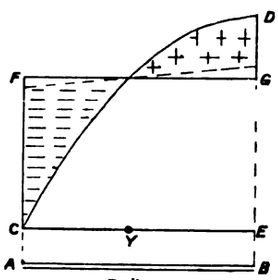

Fig. 3.

NEGATIVE BOOSTERS.

The writer had experience with the first negative booster introduced, which was running in connection with the Bristol Tramways in 1897.

Originally, booster cables were run at high current density, and the boosters were designed for a voltage ranging from 80 to 120. This was found to be very uneconomical, and present practice favours 40 volts as being the largest loss that can be considered economical.

Although the voltage generated by the armature of booster is directly proportional to the current passing through the field coils in series with trolley wire feeders, a booster throughout its range cannot perfectly compensate for the drop in cables. Hence the motor and booster should be developed from apparatus which would normally have nearly twice the capacity at which it is rated as a motor generator set, as it will be readily seen that if the field magnets are saturated, automatic regulation ceases.

A few remarks upon the calculation of boosted return conductors may be of interest. In Fig. 4 we have a route length of seven miles, and for simplicity, consider the power-station to be situated in the centre of the system. When the resistance of the rails is known and the car service and average speed, it is an easy matter to calculate the total amount of current to be returned, and the points where the return conductors should be connected to rail.

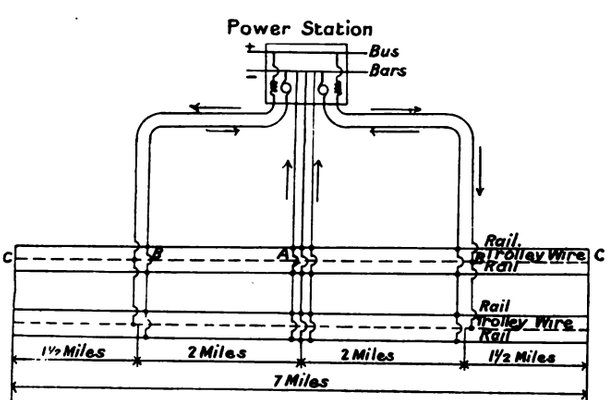

Fig. 4.

Assume cars have a two and a half minutes' service, and are running at a speed of eight miles per hour. From point A to end of track on either side there would be twenty-two cars about 586 yards apart, and the total current (at 25 amperes per car) would be 550 amperes. From point B to end of line we should have nine cars taking a total current of 225 amperes.

The current from A to B we will assume will be returned by the non-boosted cable near the power-station. Four well bonded 100 lb. per yard rails will have a resistance of about ·012 ohms per mile, and on the system indicated we should have approximately a D.P. of 2·5 volts between the end of track and point B.

To deal with the current beyond point B, two negative boosted cables should be bonded to the rail from one-half to two-thirds of the distance from centre of system to the extreme ends, and preferably also two positive feeders should feed the trolley lines near these points,

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so that each booster armature would be excited in proportion to the load. The arrow heads show the direction of flow of current back to the station. Assuming that points B were two miles from the power-station, two cables each of ·5 square inch sectional area would be required to carry the current from the above points (at a density of 450 amperes to the square inch) through the booster armatures to the power-station, and the voltage required for this load from each machine would be approximately 39 volts.

The relative length and sectional area of non-boosted and boosted feeders on a system, determine the amount of current returned through the booster cables with a given pressure. Where there is a long distance between the power-station and the nearest connection to rail, there will always be the D.P. between these two points tending to return current to negative busbar. This must be borne in mind when

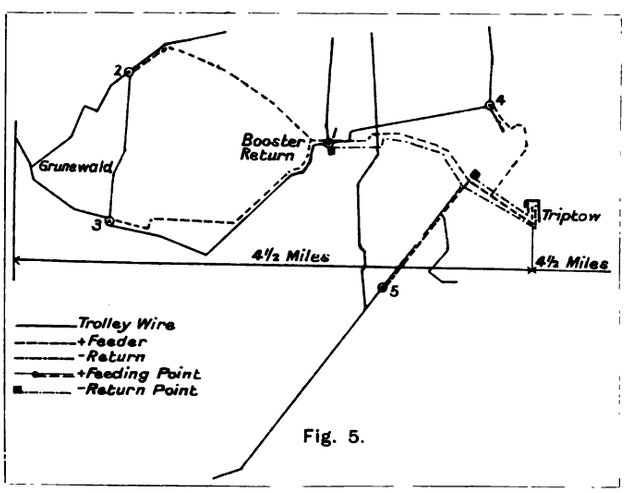

Fig. 5.

capacity of booster and sectional area and length of cable for same is determined, whereas, when the rails are in close proximity to the station, with only a small pressure between rails and negative busbar, the voltage generated by the armature of booster alone will determine the current returning by the boosted cable.

Fig. 5 illustrates the system of feeders and returns on the Schöneberg Tramways, at Berlin, a description of which appeared in the *Electrotechnische Zeitschrift*. The longest distance from the power-station extends in an east to west direction from Grünewald to Treptow, and is approximately 4½ miles. As heavy traffic only occurred on Sundays, it was not deemed necessary to instal a polyphase or alternating-current gene ating station with sub-stations, and an ordinary D.C. system with booster return cables was adopted.

There are five positive feeding points, and on the rail return there are two points where the return cables are connected, viz., to point P, near the generating station, and the other to rail point 1, situated near the positive feeding point 1. This point is connected to the generating station through the booster armature by a cable 1·7 sq. in. sectional area. The field excitation of the booster is provided by the total feeding current to points 1, 2, and 3. (In the illustration the parallel feeders are indicated by a single dotted line.) The currents flowing to these three points return to the generating station by means of the booster return cable, whilst the current flowing to points 4 and 5 return direct by means of the rails. These rails were found too small for the heavy current, and the D.P. too great, hence supplementary cables were connected to rails having a total sectional area of 3·1 sq. in. The maximum output of the boosters for this scheme is 50 volts at 1,100 amperes.

A similar system, designed by Mr. H. F. Parshall, has been installed in Dublin and Bristol. In Dublin there are 18 positive feeding points and four corresponding negative return cables. Each of the latter return the current taken to four or five feeding points, exactly as on the Schöneberg Tramways at the point 1. The four boosters at the generating station are each excited by the current to four or five positive feeders, which number may be altered as desired by an arrangement of switches at the power-station. On the Bristol tramway system there are three negative boosters, each dealing with an average load of 1,000 amperes at 40 volts. Two of these are excited by three positive feeders, and one is excited by two positive feeders.

Rails and Electrolysis.

As it has been found that rails low in carbon but of high electrical conductivity wear far too rapidly, it is now customary to specify rails having a higher percentage of carbon, and as there are now many forms of welded rails, all of which at the joint have a conductivity less than that of an ordinary solid rail, and as manganese steel is being largely used, it is not advisable to cut down the sectional area of copper, either in bonds or return cables, to the lowest possible amount when a tramway system is designed, as oxidisation invariably takes place at joints, thereby increasing the resistance, and the writer has also found that in some systems of welding the metal has been honeycombed to such an extent that copper bonds have had to be inserted.

Fig. 6 shows a section of welded rail which before being broken in testing machine appeared to be perfect, and as this one test piece was taken from many having the same exterior appearance, it may be assumed that others are in an equally bad state, hence the advisability of having at least one copper bond across each joint. Needless to say, in a weld similar to the one shown, the resistance would increase in course of time owing to water finding its way to the porous metal and oxidisation taking place.

It is well known that under favourable conditions electrolytic action may take place with a very small difference of potential, and recommendations were made in the early days of electric traction in England to bond adjacent water and gas pipes to rail in order to prevent this action. I am not aware that this is done on any system in England, neither do I consider it necessary, for, in my opinion, it is advisable to leave all pipes to take care of themselves, as, if proper attention is given when pipes are laid as to nature of soil and corrosive properties of same, there need be no fear of further trouble caused by stray current from a tramway system if the arrangement of feeders and returns are set out in a proper manner.

It is desirable in plotting the return cables to bear in mind that in the first place it is not necessary to reduce the potential of the rails between the termini and any portion of the track below say 4 to 5 volts under normal working conditions, and where return cables are connected to rails the potential at these points should not fall below 1 volt.

Normal earth currents have always been known to exist, and the writer has taken tests in Sheffield on a Sunday morning, before the tramway service has been started, and has found the D.P. between gas and water mains to vary in different parts of the city from ·01 to ·66 volt.

It is a difficult matter to trace the cause of these D.P.'s, and without making any suggestion of possible leakage from lighting and power circuits owned by local firms who have their own generating plants, the writer does not propose to voice any theories relating to these varying differences of potential. From tests taken it has been found that the proximity of metal pipes to rails does not materially affect leakage

Fig. 6.

unless, of course, the pipes are in actual metallic contact, although where the earth has a high resistance gas and water mains interconnecting different tracks may be found to carry a higher potential than the general mass of earth. However, if the rails are kept within the Board of Trade limit of 1·48 volts there need be no fear of electrolysis taking place, for the oxides invariably produced on the surface of the rails, and also on iron pipes, form a protective coating, and tend to reduce the electrolytic current.

I find that on twenty-two of the largest Corporation tramway systems

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fifteen use paper-insulated lead-covered cable entirely; four use both lead-covered and vulcanised-bitumen cables, and three use vulcanised bitumen only.

It will therefore be seen that, although very strong opinions were expressed as to the entire inexpediency of using lead-covered cables for electric feeders, on account of the damage likely to be caused to the lead sheathing by the action of return currents, yet the largest and most important undertakings have adopted lead-sheathed cables with excellent results and, in the writer's opinion from actual experience of many classes of cables, lead-covered cables are entirely satisfactory, provided the sheathing is continuous and effectively earthed. It is well known that earthing the lead covering at wrong points may actually cause electrolytic trouble instead of preventing it.

Of the fifteen systems above mentioned thirteen earth their leads either to rail, water main, or earth plate, and in only two instances are leads not earthed.

In the writer's opinion it is most desirable to effectively earth the sheathing of cables, as it is possible to produce local heating (which may produce a spark capable of igniting an explosive mixture of gas) by reason of an electro-magnetic inductive effect upon the lead when, say, a circuit-breaker is cutting off a heavy load or a short circuit owing to the rapid change in the number of lines enclosed by the circuit formed by the lead sheathing, an imperfect earth connection, and the mass of earth. This inductive effect would, of course, be intensified where cables are laid in iron pipes. A sufficiently high potential to cause a spark could only be attained if the lead sheathing was reasonably well-insulated from earth throughout its length except at a point where an imperfect contact is made, and a spark would then pass from lead to earth. In nearly every case a drawing-in system of cable laying is adopted in connection with tramway systems, principally owing to the facility afforded for withdrawing small cables and substituting larger ones as the system extends. Of 16 large systems, 14 have a drawing-in system only, using iron and earthenware pipes, and in only two cases are cables laid on the solid system.

Board of Trade Regulations.

I purpose briefly to deal with the special regulations directly relative to the paper.

The following methods have been adopted on 22 Corporation tramway systems:

Reg. 5 (*a*)	Earthplates near rail..	8
	At power-station	4
	At both places..	1
	Where earthplates are not in use	9

The average size of earthplates used is 5 ft. square.

The revised regulations of the Board of Trade dated August, 1904, regulation 5 (*b*), stipulate that earth connections not less than 20 yards apart shall be constructed, laid, and maintained so as to secure electrical contact with the general mass of earth so that an E.M.F. not exceeding 4 volts shall suffice to produce a current of at least 2 amperes from one earth connection to the other through the earth. On several tramway systems it has been found impossible to comply with this regulation owing to the high resistance of the soil, and in Sheffield, the soil being largely composed of shale and marl, the highest current that can be produced with 4 volts is ·35 amperes. On 14 systems, nine cannot comply with the above requirements, and on only five systems can this result be obtained.

Regulation 5 (*c*).—On nine systems, owing to the above difficulty, connection is made to water mains. The maximum current observed between earth plates (or water mains) and rail (or negative busbar) as per regulation 6 (1) amounts on 16 systems to 12·5 amperes, with an average load of 2,800 amperes.

With respect to regulation 6, it has also been found that owing to the very high resistance of the earth in several cases it is impossible to obtain sufficient current to satisfactorily operate a recording ammeter, but on eight systems the following methods are adopted:

Recording ammeter in street pillar	2
Maximum demand indicator in case, placed in cable pit	4
Shunt in cable pit, with leads to recording ammeter at station	2

The 1894 Board of Trade Regulations respecting earthplates at the power-station being connected direct to negative busbar through a recording ammeter, resulted, in the writer's opinion (based on experience), in serious damage to lead covered cables, for it will be readily seen that, where a power-station is situated some distance away from the track, owing to the drop of potential on return cables, there will always be a D.P. ranging in some cases according to distance and load, from ten to twenty volts between rails and negative busbar. Consequently, when there is a path of low resistance from the earth plates near the power-station to negative busbar, you invite current to return *via* the lead covering of cables, and the writer has seen numerous cases where serious oxidization has taken place, this being especially noticeable in most cable pits where the lead has been resting on bell mouths of iron pipes, with the result that a white deposit has been formed. Happily the Board of Trade regulations were revised in 1903, and it is now specified that the generator shall have no other connection with earth save than by that of insulated return cables. This revision entirely obviates trouble, provided the lead sheathing is effectively earthed at suitable points.

With respect to leakage from lines and feeders, it has been found that the regulation of ·01 amperes per mile can easily be complied with. Under normal conditions the leakage on fourteen tramway systems does not exceed ·005 amperes per mile.

The latest Board of Trade regulations, dated August, 1904, stipulate that the maximum current on rails should not exceed 9 amperes to the square inch. This regulation is likely to affect systems where there is a large amount of double track on outlying districts joined by a single line, say in narrow streets near the centre of system.

On fourteen large tramway systems no trouble is anticipated with respect to this clause, but four express the opinion that there is likely to be a difficulty in attempting to comply with this regulation.

LONDON COUNTY COUNCIL TRAMWAY MATTERS.

Fresh Tramway Capital Expenditure.

At a meeting of the London County Council on April 4, the Finance Committee presented a report containing the annual estimates. They stated that the estimates represented the amounts which the various Committees desired to spend during the year 1905-6, and during the half-year to September 30, 1906. Some of the works were already in hand; some were within the powers of the Council, but not yet sanctioned by them; and some were works under bills promoted in the present session of Parliament. Considering the estimates as a whole, the Committee pointed out that experience had shown that such estimates had invariably proved to be much in excess of actual requirements, and the Finance Committee had impressed upon the other committees the necessity of keeping the estimates as closely as possible to actual requirements, and this was now to a large extent being done. The total estimates now submitted for the year 1905-6 amounted to £5,860,470, including £500,000 for contingencies. The total estimates for the half-year ending September 30, 1906, were £2,399,400, including £200,000 for contingencies. Out of these totals, the expenditure for tramways was put at £1,100,000 for the year 1905-6, and at £400,000 for the half-year ending September 30, 1906. Under the Council's Subways and Tramways Act the estimate for the year was £53,000, and for the half-year to September 30, 1906, it was £22,000. For the corresponding periods the estimated expenditure under the Council's bill in the present session, if it became law, was £97,000, and £83,000. The total tramway estimates accordingly for the two periods were £1,250,000 and £505,000 respectively.

Car Shed for Hammersmith.

The Committee stated that their attention had been drawn to some freehold property in Hammersmith Road, which was about to be sold, and the site of which seemed to be admirably adapted for the erection of a car-shed required for the working of the tramways from Putney Bridge to Harlesden. The Committee had reported on the subject, and the Council had approved an estimate in December last of £9,500 to cover the cost of acquisition. The Committee now reported that the site had been acquired for £9,000.

Chief Officer's Visit to America.

The adjourned report recommending the chief officer's visit to America was now unopposed, and was adopted without debate.

Tramways *v.* Motor Omnibuses.

On the adjourned report recommending construction of the Battersea, Wandsworth, etc., tramways on the conduit system,

Sir Melville Beachcroft moved the reference back on the ground that the route proposed was suitable for the overhead system, or at any rate a combined system of trolley and conduit. He had grave doubts whether it would be possible to electrify all the tramways on the underground system, and believed that the Council would have to face the question of more economical construction. Developments were in the air, and better methods might shortly be discovered to supersede existing systems.

Mr. A. Smith pointed out that the local authorities objected to the overhead system.

Mr. S. Collins urged that what had been done for other districts should also be done for Wandsworth.

Mr. T. P. Gaskell supported the Committee's report, thinking that the Council having commenced with the conduit system must continue that system. In certain parts of the new route there would be great objection to the trolley system.

Mr. E. Collins contended that the trolley system was not as unsightly as represented, and that the coming of the motor 'bus should influence the Council in adopting the most inexpensive form of traction.

Mr. J. Burns, M.P., strongly opposed the amendment, on the ground that the district concerned was no longer suburban in character. He advised the Council, even if electrifying the Northern system, to take

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the plunge boldly for the conduit, and suggested that for a city like London only the best system, although costly, was at all worthy.

Mr. J. W. Benn, M.P., said a circular had been sent to the members of the House of Commons asserting that the tramways did not pay. The Council had now had seven years of municipal tramways. In the first four years they relieved the rates by £83,000. Then came reconstruction, and with it a loss of £2,000. With the losses they had been able to show a relief of £69,000, and had, in addition, carried the largest share of street widening cost. This year they were about to relieve the rates by £6,000. Could they have done better with the southern tramways if they had accepted the offer on the same terms as granted to the North Metropolitan Company? The Comptroller had pointed out that all they could have got was £14,500 a year. Now they got by working their lines, £10,000 in relief of the rates, £10,000 in cheaper fares and other concessions, which altogether represented some £40,000 a year. Turning to the subject of motor 'buses, Mr. Benn said that at the Elephant and Castle in the busiest part of the day they had 436 electric cars passing that point per hour. It would require 1,000 motor 'buses to carry the same number of passengers. Look at the space occupied, to say nothing of the aroma. (Laughter.) Passing on to the subject of the use of main thoroughfares, Mr. Benn said that while motor 'buses paid nothing for the use of the roads the electric trams supported the track and paid rates on it. The tramways, in fact, were great contributors to the rates. The motor 'bus, on the other hand, could cut up the roads and compete with the tramways. In spite of that they did not fear that competition. The motor 'bus was a useful vehicle that had a great future, but it would be as a feeder to, not a competitor with electric tramcars.

Mr. Allen Baker briefly replied, and explained that the combined system had been under consideration, but there were physical difficulties in the way of its adoption on the proposed route. With regard to motor 'buses, the time was coming when they would have to consider how to make the users of the roads who now escaped payment contribute their fair share of the cost of upkeep.

The amendment was rejected on a division by 87 votes to 15, and the Committee's report was adopted.

Data Relating to Tramway Costs.

On the reception of the report of the Finance Committee,

Captain Swinton asked Lord Welby, as chairman of the Finance Committee, whether he would consider the advisability of bringing up a report showing what profit or loss had been made on the northern system, which was leased to a company; what had been made on the southern system; and what was the gross cost to the ratepayers of the widening of the streets along which tramways were laid or were to be laid?

Lord Welby, in reply, said that, while not admitting the uncertainty in the minds of the public as to the paying properties of the tramways, he would be quite happy to place before the Council in clear terms the financial position of the tramways. The proper time to raise this discussion would be, he thought, when the estimates of the Highways Committee were before the Council. He would take the first opportunity of consulting the chairman of the Highways Committee as to whether such a return as that asked for could be obtained.

The estimates submitted by the Finance Committee were approved.

In reply to Mr. Hardy,

Mr. Allen Baker said the Denmark Hill tramway would be one of the first to be constructed, and he hoped it would be ready for the opening of the new generating station next year.

Battersea and Wandsworth Tramways.

At a meeting of the Council on April 11, the Highways Committee urged the Council to proceed as soon as possible with the reconstruction of the tramways in Battersea and Wandsworth. They recommended that an expenditure on capital account not exceeding £26,000 be sanctioned in connection with the lowering or removal of drains, wires, etc., rendered necessary by the reconstruction of the tramways, and that the Committee be authorised to make arrangements with the Metropolitan Water Board and the several companies concerned to carry out the work at the cost of the Council.

Salaries of Tramways Staff.

The Committee announced that they would submit in due course an estimate in respect of the salaries of the staff required for the lines which were about to be constructed. Up to the present time the salaries fixed by the Council had been £7 per week each for the resident engineers, and £5 per week each for the assistant engineers. In order to ensure the retention of the services of skilled assistants, the Committee considered that higher maximum rates should be fixed, and they proposed that the salaries of resident engineers should be at a rate not exceeding £8 per week, and those of assistant engineers at a rate not exceeding £6 per week each. They recommended that an expenditure on capital account of a sum not exceeding £2,500 be sanctioned in connection with the engagement of temporary assistants, and that the Committee be authorised to make the necessary arrangements for the engagement of the staff.

Construction of Highgate Tramways.

The Committee reported that they had conferred with the Middlesex County Council with regard to the arrangements to be made for working the authorised tramways in Archway Road, Highgate, on the overhead system of electric traction. It was suggested that the new lines should be worked, in the first instance, as part of the light railways outside London, which have been constructed by the Middlesex County Council to the county boundary at Highgate Archway, and which would shortly be opened for traffic. Immediately after the Easter vacation the Committee intended to submit to the Council the terms of agreement which it was proposed should be entered into between the Council, on the one hand, and the Middlesex County Council and its lessees, the Metropolitan Electric Tramways, Limited, on the other. They considered it desirable to obtain the necessary tenders in the meantime in order that the Council might be in a position to commence work of construction as soon as possible. They recommended, therefore, that the Highways Committee be authorised to obtain tenders for the construction of the Archway Road tramways, and that the chairman or vice-chairman of the Highways Committee be authorised to open the tenders during the Easter vacation.

North Metropolitan Tramway Question.

The Highways Committee also submitted a long special report dealing with the acquisition of the remaining term of the lease to the North Metropolitan Tramways Company. The Committee pointed out the importance of the speedy adoption of electric traction on the northern lines, and stated that they had come to the conclusion that the only way in which this could be achieved was for the Council to obtain possession of these tramways. The Committee referred to the prolonged negotiations which had taken place with the North Metropolitan Tramways Company, and to the fact that as only about four years of the lease to the Company had now to run, the time remaining was not sufficiently long to compensate the Company for the dislocation of traffic which must occur during the period of conversion. If the work of reconstruction could be put in hand forthwith, the electric working of the northern system would be expedited by four years. If the reconstruction of the first section (22½ miles single track), which the Council had already decided should be reconstructed on the conduit system, could be completed by the time of the opening of the Greenwich station, the additional load on that station would ensure an economy in the working compared with the present cost of working the southern system which was estimated at a very considerable sum. The Committee had been in communication with the Tramways Company, and the basis of their negotiations had been the surrender of the undertaking by the Company on April 1, 1906, upon certain payments being made. The Company had expressed its willingness to sell its interest to the Council for £121,000, and the Committee were of opinion that this was a fair sum. The figure included for the profits of the Company was based on the capitalised value of the estimated net divisible profits for the 4¼ years of the lease which would still remain. It was also proposed that the Council should pay to the Company for the horses, cars, etc., £314,586. This figure would be subject to adjustment in the event of a valuation differing from it. If this plan were carried out, it would be possible to make the preliminary arrangements for reconstruction to be begun immediately after acquisition, so as to permit of the first portion to be ready for electric working by Christmas, 1906. It was proposed that Mr. H. C. Godfray, solicitor to the Company, should be retained by the Council until the date at which the lease expired—viz., June 24, 1910—to deal with third-party claims, at a fee of £1,000 per year.

The Committee had had before them calculations of the results of the electric working of the lines and authorised extensions on the basis of about half being reconstructed for the conduit system and the remainder for the trolley system. From this it was estimated that the annual mileage would be 21,024,000, and that the profit on working at 5d. a car-mile would amount to £438,000 a year, and deducting 1d. per car-mile for renewals, or £87,600, there would be an estimated profit of £350,400. The interest and repayment charges would be £36,000 on the existing horses debt, and £216,500 on the additional outlay on reconstruction for electric traction. These together amounted to £252,500, and when that sum was deducted from the surplus revenue there remained a balance of £97,900.

These figures excluded the question of street widenings, and if any part of the cost of such widenings was brought into the tramways account the profit would be correspondingly diminished. If the whole of the northern lines were reconstructed on the conduit system an additional capital expenditure of about £470,000 would be involved, resulting in additional annual capital charges of about £32,250. The Committee proceeded to refer to various questions which had been in dispute between the Council and the company, and it was suggested in the proposed agreement that these should now be settled. In the event of the Council adopting the proposals, the directors of the company would at once summon a general meeting of the shareholders, with a view to the confirmation of the arrangement. The Committee now asked the approval of the Council to estimates of £121,000 and £315,000 for the acquisition of the company's interest in the lease, and for the rolling stock, horses, plant, etc., respectively. They also sought

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confirmation of the suggested agreement and of the settlement of the points in dispute.

MISCELLANEOUS.

The Committee reported that the reconstruction of the tramway junction between the tramways in Camberwell New Road and Church Street, Camberwell, had been completed, and that a short junction line had also been constructed from Camberwell New Road to the authorised tramways in Denmark Hill.

It was recommended that the rate of pay for night inspectors engaged at the various tramway depôts be from 32s. to 45s. per week, the previous maximum having been 42s. per week.

All the tramway reports were adopted without debate or question, except the report of the Highways Committee on the acquisition of the North Metropolitan Tramways' lease which stood over until next meeting in accordance with the standing orders.

Mr. W. B. Bawn moved the following motion: "That it be referred to the Highways Committee to consider and report upon the desirability of an instruction being issued that only one fare shall be demanded in each case where a blind person accompanied by a guide travels on the Council's tramways."

Mr. J. Allen Baker opposed. He said the Committee had already considered the matter; the tramways were not run as a benevolent concern, but on business lines.

Mr. Jefferys pointed out that the concession would be a very small one monetarily.

Mr. Sanders said the conductors could not be expected to know whether persons were really blind or not.

Mr. Bawn, in reply, said tickets would be issued by the Blind Societies.

The motion was defeated by a large majority.

THE NORTH METROPOLITAN COMPANY'S LEASE.

At the meeting of the Council on April 18, the Finance Committee reported that the Highways Committee had forwarded to them capital estimates of £121,000 and £315,000 in respect of the acquisition of the remaining term of the lease of the Council's northern tramways granted to the North Metropolitan Tramways Company. The Finance Committee regretted that owing to the very short period between the receipt of these estimates and the adjournment of the Council for the Easter recess they were unable to submit the estimates before Easter, but they hoped to be in a position to do so at the first meeting of the Council after the recess.

PRECAUTIONS AGAINST FIRE IN TUBE RAILWAYS.

In a report presented by the Fire Brigade Committee, it was stated that in the end of 1904 the Council had approved the course taken by the Committee in informing the Board of Trade that the Council would raise no objection to the Board's proposal that the chief officer should express an opinion as to the sufficiency of the provision made in compliance with the Board's requirements as to efficient hydrants, hose, and fire prevention appliances for the underground electric railways. The chief officer, it had been agreed, was to express an opinion only on one point, viz., the sufficiency of fire appliances. The Committee had been in further communication with the Board, and an arrangement had been arrived at. The Board would serve on promoters of underground electric railways in London its requirements as regards fire precautions, and also the minimum requirements suggested by the Council as regarded fire appliances. The Board would also call upon promoters to furnish the Council with plans of their railways and stations, showing the fire hydrants and other fire appliances proposed to be provided. On receipt of these plans the Fire Brigade Committee would obtain reports from the chief officer, and their decisions on the plans and any further requirements would be communicated to the Board, who would then deal with the promoters. The Committee recommended approval of this procedure.

CONSTRUCTION OF NEW TRAMWAYS.

The Highways Committee reported that they intended to submit to the Council immediately after the Easter vacation proposals for the construction of certain tramways that had been authorised under the Council's Acts of 1902 and 1904, and the reconstruction of some small sections of existing lines. The new tramways were:

1. From Camberwell Green to the junction of Lordship Lane and Crystal Palace Road.
2. From the termination of the above line to Dartmouth Road, Forest Hill.
3. From Grove Vale to Stuart Road.
4. From New Cross Road to High Street, Lewisham.
5. From the existing terminus in Trafalgar Road, Greenwich, to the Blackwall Tunnel.
6. From Hammersmith Broadway to Lower Richmond Road.

The lines to be reconstructed were:

7. From High Street, Lewisham, to Rushey Green.
8. The existing line in Vauxhall Bridge Road.
9. A portion of the Woolwich and South East London Tramways in Woolwich Road.

The total length of the tramways affected was equal to about 23½ miles of single line, and the Committee desired to obtain approval to the system of electric traction to be adopted. In view of the fact that the whole of these tramways, with the exception of the line from Hammersmith to Putney, would be in intimate connection with the existing southern system, the Committee were of opinion that the work should be carried out upon the conduit system. As regarded the Hammersmith lines, the Act authorising them required conduit traction. Five of the above-named schemes were within a radius of three miles from the Greenwich Observatory, and it was improbable that any but the conduit system would be allowed thereon unless under special conditions. The Committee suggested that, to save time, the plans should be forwarded to the Board of Trade and to the local authorities concerned. The Committee recommended that the Board of Trade be asked to approve the adoption of the conduit system on the tramways specified.

MOTOR GENERATORS FOR SUB-STATIONS.

The Highways Commtttee further reported that they had considered the question of the additional plant which would be required as soon as the Greenwich generating station should be completed. It would now be necessary to obtain eight additional induction motor generators for the sub-stations at Greenwich, Clapham, and Streatham. These machines, together with those which would be transferred from the Bank Side temporary station to Brixton and those which were already permanently installed, would be sufficient for all the tramways to be worked in the near future from these sub-stations. Tenders had been received for the eight motor generators as follows:

	£	s.	d.
Bruce, Peebles, and Co., Ltd., Edinburgh	12,800	0	0
The Electrical Co., Ltd., London	14,364	0	0
Dick, Kerr and Co., Ltd., London	14,747	10	0
" " " (alternative tender)	13,660	0	0
The Electric Construction Co., Ltd., Wolverhampton	14,940	0	0
The General Electric Co., Ltd., Birmingham	15,491	0	0
The Brush Electrical Engineering Co., Ltd., Loughborough	15,590	0	0
The British Westinghouse Electrical and Manufacturing Co., Ltd.	16,329	0	0
The British Westinghouse Electrical and Manufacturing Co., Ltd. (alternative tender)	15,917	0	0
The Phœnix Dynamo Manufacturing Co., Ltd., Bradford	17,187	0	0
Siemens Brothers and Co., Ltd., London	17,415	15	0
" " " " (alternative tender)	15,986	15	0
The British Thomson-Houston Co., Ltd., Rugby	17,934	0	0
The British Electric Plant, Co., Ltd., Alloa, N.B.	18,728	0	0
Johnson and Phillips, London	19,817	0	0

None of the alternative tenders met the Council's requirements. The lowest tender was not in accordance with specification, and the second one was not in order. The Committee were of opinion that the third tender—viz., that of Dick, Kerr and Company, Limited, amounting to £14,747 10s., should be accepted, as the machines offered by this firm were of a much more suitable nature, and would justify the additional expense.

ADDITIONAL EQUIPMENT FOR GREENWICH POWER-STATION.

The Committee on this subject pointed out that in October, 1904, the Council sanctioned an expenditure of £3,000 for the wiring and fitting, for electric lighting and power purposes, of the Greenwich electricity generating station, and decided that the installation should be executed by the electrical staff of the tramways department. The Committee found now that the cost of the work should be about £4,500, and they recommended that expenditure to that amount be authorised.

The Committee had considered tenders for low-tension cables, cable-boxes, etc., required for the station, the following ten offers having been submitted:

	£	s.	d.
W. F. Dennis and Co., London	2,151	3	6
Johnson and Phillips, London	2,214	13	1
The Western Electric Co., London	2,232	4	9
The British Insulated and Helsby Cables, Ltd.	2,438	17	6
The St. Helens Cable Co., Ltd., Warrington	2,446	11	3
Siemens Brothers and Co., Ltd., London	2,465	3	7
W. T. Glover and Co., Ltd., Manchester	2,523	1	0
W. T. Henley's Telegraph Works Co., Ltd., London	2,553	10	0
Callender's Cable and Construction Co., Ltd., London	2,595	1	0
The Edison and Swan United Electric Light Co., Ltd., London	2,701	8	10

The Committee were of opinion that the tender of the Western Electric Company should be accepted. The lowest tenderers proposed to sub-let the work to a German firm, but the Committee understood that the extra cost of making a detailed inspection of the material manufactured in Germany would more than counterbalance the difference between this tender and the one recommended for acceptance. They recommended accordingly that the Western Electric Company's tender be accepted.

The Committee had considered the following tenders for the general electric wiring material of the Greenwich station:

	£	s.	d.
Conduits and Fittings, Ltd., London	1,407	0	0
The General Electric Co., Ltd., London	1,413	13	11
The Armorduct Manufacturing Co., Ltd., London	1,423	14	9
The Edison and Swan United Electric Light Co., Ltd.	1,424	16	0
William McGeoch and Co., Ltd., London	1,480	0	0
The Simplex Steel Conduit Co., Ltd., Birmingham	1,697	11	11
Verity's, Ltd., London (incomplete tender)	1,144	4	0

They recommended that the lowest, viz., that of Conduits and Fittings, Limited, should be accepted, and that the tenderers be allowed to

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sublet to Messrs. Spagoletti and Company the supply of certain of the electrical fittings.

ARCHWAY ROAD TRAMWAYS.

The Highways Committee again reported on the subject of the construction and working on the overhead wire system of the authorised tramwavs in Archway Road, Highgate, connecting with the system of the Middlesex County Council light railways. The Committee now submitted for approval a definite scheme for the leasing of this line for three years to the Metropolitan Electric Tramways, Limited, the lessees of the Middlesex County Council. The Company would repair, and, if necessary, renew the lines and overhead equipment, and would work these tramways and provide the cars and electrical power. In return, the Middlesex County Council would pay the London County Council a rent of £1,500 for the first year, £2,000 for the second year, and £2,500 for the third year. The cost of construction of the lines would amount to about £5,650 and the overhead equipment to about £900, making a total of £6,550. The widening of Archway Road at a cost of about £6,000 was now nearly complete, and it was of importance that the tramway should be laid at the same time as the paving works were being carried out. The Committee recommended approval of the proposal. The Finance Committee, commenting on the subject, said that the arrangement appeared to be financially advantageous to the Council.

The adjourned report of Highways Committee on the North Metropolitan tramways stood over until after the recess. The further report of the Highways Committee regarding Archway Road tramways also stood over.

On the ordinary report of Highways Committee.

Mr. J. G. WARREN asked if the lease of the North Metropolitan Tramway Company were acquired would the whole of the East London tramways be electrified on the conduit system.

Mr. J. ALLEN BAKER, in reply, said the question was premature. The Council thought half the lines in the north should be electrified on the conduit system; the remainder was still a matter for decision by the Council.

The report was adopted, and the Council rose for the Easter recess.

LONDON ELECTRIC POWER BILLS.

In the course of the further consideration by the Select Committee of the House of Lords, presided over by the Earl of Camperdown, of the Administrative County of London and District Electric Power Company's Bill.

Mr. JOHN CONACHER, general manager of the Metropolitan Electric Supply Company, Limited, examined by Mr. Ram, K.C., on March 28, stated that with regard to the supply by existing companies to railways, tramways, canals, and docks, certain of the companies he represented and some other companies had bills before Parliament.

Mr. RAM: Is it your contention or your belief as a manager that you may now supply power to railways, canals, and so forth?—The WITNESS: Yes. We cannot find in our Orders anything which gives us a right to refuse a supply on the ground that it is to be used for any particular purpose.

Mr. RAM: There has, however, been a question raised that you ought not to be allowed to supply to railways or tramways who will take the power within your district and carry it outside and use it outside.—The WITNESS: Or take part of it.

Mr. RAM: In the bills I have spoken of, which have been promoted by the companies, is power sought to clear up that and get it made plain that such powers shall be permitted to the companies supplying electric power?—The WITNESS: That is so.

Mr. RAM: In your opinion would that make it perfectly clear that this very important customer—namely, the railway or the tramway, shall be one of our authorised customers whom you can supply?—The WITNESS: Quite.

Mr. RAM: You have no doubt yourself that you are entitled to supply such power now? The WITNESS: Yes, we have no doubt at all.

Mr. RAM: Have you, in fact, made an offer to the London County Council to supply power for their customers?—The WITNESS: Yes, we did that quite recently.

On March 31 evidence was continued on behalf of the borough councils and local authorities, following upon the evidence given by the electric supply companies against the Administrative County of London Bill.

Mr. C. H. WORDINGHAM declared that his fear of danger from the large ring mains was danger to the public from explosions, and he instanced the violent explosion which occurred in Manchester some years ago on a comparatively small main. The work had been carried out according to the Board of Trade regulations. On the question of the crowded condition of the streets as to mains, he thought it would be extremely inconvenient to have any further breaking up of the streets, but at the same time it was not impossible.

Mr. G. BELL, electrical engineer to the Hammersmith Borough Council, stated that their works were carried on at a profit. The average price for power was 1·54d. per unit, and the total works costs last year were 1·6d. The capital cost per kilowatt was £40.

Mr. S. BAYNES, electrical engineer to the St. Pancras Borough Council, stated that the amount set aside to the relief of the rates out of the profits of the electrical undertaking at St. Pancras was £10,000, and there was also a reserve fund of £30,000. The revenue last year from power consumers was £4,666. The power charge had decreased from 3d. per unit. to 1d. per unit. The demand for power had increased by 100 per cent. since the price had been decreased from 2d. per unit to 1d. per unit.

Mr. P. V. MCMAHON, engineer to the City and South London Railway Company, said that Company generated its own electricity at a total cost of 0·675d. per unit, and when the Euston extension was opened he anticipated this would be reduced to 0·611d. He could not see any advantage in a railway company taking a supply from an outside company, as all control would be lost over the generating station, which was the heart of the system, and this was the opinion of most other railway companies.

In addressing the Committee on behalf of the sixteen local authorities,

Mr. FREEMAN, K.C., employed very much the same arguments as had been used for the electric supply companies but he pointed out the exception that the companies were liable to be purchased, and the local authorities were not. His clients regarded the bill as very important from the fact that Parliament had given them the authority to invest the ratepayers' money to the extent of five and a half millions. With regard to competition, in no single instance had a company been allowed by the Board of Trade to compete with a local authority for the supply of electrical energy under a subsequent provisional order, nor had any power company been allowed to supply in competition with a borough council. Further, it had been the general rule in past years to exclude from power acts local authorities who were doing their duty, and only to give the power company a wayleave to lay mains in order to supply someone on the other side of the town. What had to be considered was that any loss which was likely to be incurred by the local authorities through the operations of the new company would have to be borne by all the ratepayers, and not only by those who were consumers of electricity. The bill would be prejudicial to the public interest generally in London.

Mr. BLENNERHASSETT, K.C., addressed the Committee on behalf of the Westminster City Council, and evidence was given in support by Mr. J. Hunt, town clerk, and Mr. J. Bradley, engineer.

Mr. LEWIS COWARD, K.C., for the London County Council, commented upon the prejudicial effect which the passing of the bill would have upon the security of the vast sums of money which the County Council had lent to the borough councils, and he argued that the proposals in the bill were premature, having regard to the existing condition of proposed legislation on the subject, and they should be rejected until the whole matter had been finally settled by the Government.

Mr. WILLIAMS spoke on behalf of the Stepney Borough Council, and Mr. W. C. P. TAPPER, electrical engineer, gave evidence in support.

On Monday, April 3,

Mr. W. BULLOCK, chief engineer to the West Ham Corporation, mentioned, in the course of his evidence, that the tramways were owned by the Corporation, and extensions were contemplated, also to be worked by electricity. There had been a large increase in the demand for power in the borough during the past 12 months, and a new generating station had been erected in consequence. The Corporation believed they could supply all power requirements at less than 1d. per unit.

Mr. H. E. BLAIN, manager of the West Ham Corporation Tramways, said it was estimated that when the whole system was completed the traffic would be 26,000,000 passengers per annum. On the general question of the breaking up of streets, there was the possibility of great inconvenience to the tramway traffic.

Mr. MORTEN, in addressing the Committee for the Corporation, referred, among other things, to their tramway system, and pointed out that once the promoters obtained consent to supply there they would have to lay their mains underneath the tramway track owing to their consumers possibly being on different sides of the road. For the inconvenience to the tramway traffic thus caused there would be no compensation; all the company would have to do would be to reinstate the road.

On Tuesday, April 4,

Mr. FORBES LANKESTER put forward the case for the borough of East Ham, mentioning that the district was largely a working class residential one, with very little demand for power, the bulk of the supply being for lighting and tramways. But if at any time there should arise a large demand for power purposes the present generating station of the Corporation was amply sufficient to meet it for many years.

The cases for the Hackney Borough Council, the Essex County Council, the Urban District Councils of Woodford, Leyton, and Hampton, and the Southwark Borough Council were next considered.

On Wednesday, April 5,

Mr. BALFOUR BROWNE, K.C., on behalf of nine electric companies in London, asked that a definite statement should be made by the

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promoters with regard to the scope of their bill and other matters. He also wanted to know something definite about the application of the scale of charges, as such information would materially assist him in conducting his opposition.

The CHAIRMAN considered that all these matters could best be discussed on clauses, if the bill should reach that stage. He could assure the opposition that it was their intention to consider very carefully the clauses, but in the meantime they must take the bill as it stood.

Evidence was then called on behalf of a large number of local authorities, and the Corporation of Gravesend, Islington Borough Council, and the Corporation of Croydon.

On Thursday, April 6,

The local authorities' opposition was closed with the hearing of the cases of Kingston Corporation and the districts of Ealing and Barnes, and the following companies were next heard: Richmond (Surrey) Electric Light and Power Company, the South Metropolitan Electric Lighting Company, the South Metropolitan Gas Company, the Gas Light and Coke Company, North Metropolitan Electric Power Supply Company, the Kensington and Notting Hill Electric Lighting Companies, South Metropolitan Electric Light and Power Company, and the County of London Electric Supply Company.

On Friday, April 7,

Mr. BALFOUR BROWNE, K.C., addressed the Committee on behalf of the whole of the electric lighting companies of London against the bill being allowed to proceed. He urged that the competition proposed to be set up was very unfair. The capital of these companies had been found on the faith of a Parliamentary grant, and he thought it would be fatal if it were once understood that Parliamentary securities were to be tampered with. If the Committee passed the bill they would be creating an absolute monopoly, a huge trust or combine, which would crush out of existence local authorities aud companies, contrary to the whole course and spirit of legislation during the past quarter of a century.

Mr. FITZGERALD, K.C., replying for the promoters, urged that the only proper way of dealing with the supply of electricity to the county of London and the adjoining district was that proposed by the bill. It was only in some such way as this that they could assure customers of the cheap supply of power which was necessary to enable London's manufacturing interests to be put on a par with their rivals, either in the country or abroad, and that they could insure to London generally that supply of cheap electricity which the customer ought to be able to get, and so remove from London the reproach that electricity was dearer here than in any large town in the United Kingdom.

On Monday, April 10,

Mr. FITZGERALD, K.C., continued his reply, and said that there being no clause in the bill allowing the purchase of the Company's undertaking by a local authority was due to the facts of the case, and the recommendation of the Joint Committee of both Houses, presided over by Lord Cross, that where sufficient public advantage was shown power might be given over an area including the areas of several local authorities, involving plant of exceptional dimensions and high voltage, upon conditions differing from those found in existing Acts.

The CHAIRMAN said it was unnecessary to argue the point—that of making undertakings of large companies purchasable by local authorities. The Committee had no intention of departing from the recommendation of Lord Cross's Committee.

Mr. FITZGERALD went on to argue that the absence of purchase power was no injustice to any party concerned. The present project was designed by gentlemen thoroughly acquainted with the subject, every detail had been thought out, every estimate had been based on actual figures, and behind the scheme were a number of promoters whose financial ability to carry it out was undoubted.

At the conclusion of Mr. Fitzgerald's address,

The CHAIRMAN intimated that he would have to consult Lord Romilly, who, through illness, had been prevented from attending the last two sittings, before the Committee proceeded further.

Subsequently the Committee decided to adjourn the proceedings until May 9.

TRAMWAY AND ELECTRIC RAILWAY LEGISLATION.

The House of Lords rose for the Easter holidays on April 14, and the House of Commons adjourned for its corresponding vacation on April 19.

SECOND READINGS.—In the House of Commons, March 31: London Southern Tramways. April 10: Metropolitan District Railway, Tyneside Tramways and Tramroads. April 17: Metropolitan Railway, West Cumberland Electric Tramways (Extension of Time). April 18: Mexborough and Swinton Tramways (Extension of Time).

THIRD READINGS.—In the House of Lords, April 3: West Cumberland Electric Tramways (Extension of Time). April 4: Metropolitan Railway. April 7: Mexborough and Swinton Tramways (Extension of Time). April 13: Southend and Colchester Light Railways, South Eastern, and London, Chatham, and Dover Railway.

In the House of Commons, April 5: Accrington Corporation. April 10: Birmingham Corporation. April 17: Whitechapel and Bow Railway. April 18: Great Western Railway (New Railways).

ABERDARE TRAMWAYS.—This bill was before a Committee of the House of Commons on March 30 and succeeding days. It proposes to authorise the Urban District Council to construct and work tramways in the town, which has a population of 47,000. It was explained that several street improvements and the erection of a dust destructor were to be carried out in connection with the scheme, the total cost of which was estimated at £93,576. There was a good deal of opposition by the Taff Vale Railway Company, and by frontagers. The former declared that the tramways were unnecessary, and that they would compete with the railway. The frontagers and other property owners maintained that the tramways would not pay and that the ratepayers would suffer. In response to a request by the Committee the promotors handed in an estimate of the financial result of working the tramways, which showed a profit of £1,000. After further consideration, the promoters presented another estimate showing that, when everything was taken into consideration, it was probable that at first the working of the tramways would result in a loss sufficient to require a charge on the rates of ¾d. in the £1, but in view of the financial position of the district they thought this would not be excessive. On April 6 the Committee rejected the tramway proposals of the bill.

CROYDON CORPORATION.—This bill, which, among other things, proposed to give the Corporation power to run motor omnibuses and to construct some short additional lengths of tramways, was before a House of Commons Committee on April 11 and succeeding days. The motor 'bus proposals were opposed by the British Electric Traction Company, and by some neighbouring local authorities. For the promoters it was stated that in order to meet the opposition they would withdraw a proposal to acquire land for omnibus houses, and would confine the running of the omnibuses to certain specified routes. In evidence, witnesses for the promoters said that it was proposed to purchase twelve motor 'buses for £12,000, and run them on any of thirteen routes which were specified, none of which went more than a mile beyond the borough boundary. Tramways had been authorised along some of these routes, but the construction of them had not yet been begun. The Committee, after deliberation, struck the motor 'bus proposals out of the bill, but they sanctioned the tramway extensions.

HALIFAX CORPORATION.—This is a bill dealing with many matters, and among its proposals are those for the construction of additional tramways.. The measure was before a Committee of the House of Commons on April 5. For the promoters it was stated that it had been originally intended to ask for lines outside as well as inside the borough, but the proposals for the outside lines had been dropped. The remaining lines were sanctioned by the Committee. Separate consideration was given to Clauses 31 and 34 of the bill, which conferred powers to enable the Corporation to carry on their tramway undertaking in conjunction with adjoining tramway undertakings. Objection was made to this by railway companies concerned, who maintained that the powers sought were too wide, and would possibly enable the Corporation to connect with tramways very remote from Halifax, to the detriment of the railway companies. For the promotors it was stated that in order to meet this objection, the operation of the clauses had been limited to the tramways of Bradford, Huddersfield, Keighley and Todmorden. It was in the interest of the community generally that these powers should be granted to Halifax. The gauges of some of the tramway systems differed, but it could be got over by laying a third rail. It was also admitted that in some cases further legislation would be necessary before some of the through running proposals could be given effect to. The Committee decided to strike out Clauses 31 and 34.

LONDON UNITED TRAMWAYS (EXTENSION OF TIME).—This bill, it was announced on April 14, was unopposed, and it was referred to the House of Commons Committee on Unopposed Bills.

RHONDDA URBAN DISTRICT COUNCIL.—A Committee of the House of Commons disposed of this bill on April 10. The measure proposed to extend the time for the acquisition of land and for the completion of authorised tramways, and it was opposed by colliery proprietors and frontagers. The Committee found the preamble of the bill proved as to the extension of one year for the acquisition of land, but they rejected the proposal to extend the time for the completion of the tramways, on the ground that the time now at the disposal of the promoters was sufficient. The Chairman of the Committee (Sir L. McIver) pointed out that the promoters had still four years for the completion of the tramways, and said the work could be quite well done within two years.

SOUTHEND AND COLCHESTER LIGHT RAILWAYS.—After slight opposition this bill was passed by a Committee of the House of Lords on March 31. It seeks to authorise the Southend and Colchester Light Railways Company to construct piers with pavilions at various points on the Essex coast and to work ferries from the piers.

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LIGHT RAILWAY APPEAL.

MIDDLESEX LIGHT RAILWAYS.

On Wednesday, April 5, at the Board of Trade, Sir Herbert Jekyll heard an application in support of an Order promoted by the County of Middlesex, under the County of Middlesex Light Railways (Extension of time) Order, 1905, to enable the county authority to complete certain light railways authorised in 1901 which had not been completed before the expiration of the period limited by the Order, 1904, and with slight alteration, to bring the form of the Order into harmony with more recent procedure.

Mr. R. W. Harper appeared for the County Council; and opposition was offered by Mr. H. Nield, for the Friern Barnet Urban District Council; Mr. Clement Edwards, for the Wood Green Council; and Mr. E. Crowne, for the Tottenham Urban District Council. There were also present for the County Council, Mr. S. H. Perrin (for Sir R. Nicholson, solicitor), Mr. H. T. Wakelain (engineer), and Mr. C. Hayley Mason (valuer).

In the case of Friern Barnet, objection was taken in respect to the widening of certain roads to 50 ft., and Mr. NIELD stated the facts of the case since 1901, and alluded to the promotion of several Orders. He argued that the obligation which was imposed by the Lands Order of 1903 clearly imposed an obligation to widen in accordance with the plans deposited, and he submitted that it meant distinctly that so much of the Friern Barnet road upon which the Order of 1901 authorised a light railway to be made might be widened to the extent shown by the book of reference and plans deposited, and that was 50 ft. The dispute between the Councils was founded upon a misunderstanding originally.

Sir H. JEKYLL asked whether section 5 of the Order of 1903 was not permissive rather than mandatory.

Mr. NIELD said that might be so, but it was quite sufficient for his Council, because if the County Council had the power they would exercise it at once. He said they had the power, and to hold otherwise would be to depart from the whole policy of the County Council since 1901 that the road should be of a minimum width of 50 ft.

Mr. HARPER said there had been a misunderstanding. It was perfectly clear that originally when the Council projected a line along this road it was of opinion that the character of the road would not necessitate the width, and no width was scheduled. When the Light Railway Commissioners made their inspection they were of opinion that the particular pieces ought to be widened before they sanctioned the scheme. Those were the portions which were specifically referred to in sub-section 6 of section 5 of the Order of 1901, and that was the only part that dealt with road widening in Friern Barnet. The rest of the roads were dealt with in another part. In the petition from Friern Barnet they said they understood there was an absolute obligation as to widening. It having appeared subsequently that there was no power to acquire compulsorily any land for the widening, the lands Order of 1903 was promoted. He had had an opportunity of seeing the deposited plans, and it was true that lands were scheduled there along the whole length, and the limit of lands to be acquired was indicated on the plan. His difficulty was that this was an extension of time Order from the 1901 Order.

Sir H. JEKYLL: Do I understand you are in substantial agreement with the Urban District Council upon the point at issue?

Mr. BURT (an Alderman of the County Council): I should like to say that the Committee considered this matter at their last meeting, and they were not aware that any deviation had been made from the time of the original draft. It came upon them as a surprise; they are quite willing to carry out their obligation, and that this road should be widened to 50 ft. except in such cases where the cost has been prohibitive. The matter has been referred to a sub-committee to deal with, and that sub-committee will go into the question of whether there is any point upon which it is necessary to come to you. We are quite prepared, if there is no power—if there has been some accident or slip—to promote a further Order to obtain it. But I hope that you may be able to rule that there is power under the clause, or in some other form, that you can make an addition to the Order.

Sir H. JEKYLL: It is a technical point.

Mr. BURT: If you could put in such words as "to widen on either side," and not confine us to the northern side.

Sir H. JEKYLL: Am I to understand that the parties are practically agreed on the merits, but that it is a question of whether the promoters have the power under their existing Orders to carry out what both sides are agreed upon?

After further discussion,

Sir H. JEKYLL said: There are so many technical points that I cannot express an opinion upon it at the present moment, but we will look very carefully into it, and it may be possible to carry out your wishes by an amendment of the extension Order which is before us now. Supposing we find it cannot be done in that way, would the promoters be prepared to promote another Order to carry it out?

Mr. BURT: If we have the power, and you say you cannot vary it in any way, we shall certainly promote another Order. But that only means delay, and we are anxious to get on at this important time.

Sir H. JEKYLL: Then we will leave it there.

In the case of Wood Green, permission was asked for the insertion of a clause as to rating in effect, that the rating of a light railway should be equivalent to that of a tramway authority.

Mr. HARPER suggested that there was no power to deal with rating in the Light Railways Act. It was a general law of the land which was sought to be altered, and unless there was a specified power to deal with it it was not in the competence of the Board to make such a provision.

Mr. EDWARDS submitted that the point was not primarily essentially one of rating, but as to whether a particular general enactment relating to railways did or did not apply, should or should not apply. In the Order of 1901 they had exempted certain general Acts relating to railways, and they were asked here to exempt another enactment which the lessees in this case contended related to them, and to say that it should not. He thought the Act did apply to a light railway, that it applied to a light railway under circumstances that were analogous to that of an ordinary railway company; they did not think it applied to a light railway under circumstances which were analogous to a tramway company.

Sir H. JEKYLL: You draw a difference between land which is used exclusively for a railway and land used for other purposes.

Mr. EDWARDS replied that that was so. Guided by an expression of opinion of Mr. Justice Wills, all they were asking for was a declaration. The general idea with regard to the Light Railways Act was that it was for the purpose of developing hitherto undeveloped districts; it was not contemplated primarily that it should in very populous districts be used as a substitute for the Tramways Act, although that had been done in many cases, with qualifications. In a case of this sort the conditions were quite analogous to the case of a tramway.

Mr CROWNE, for the Tottenham District Council, fully concurred, and said it was entirely a question of the loss or receipt of rates.

Mr. HARPER said that so far as he knew no suggestion had ever been made that the Board of Trade had ever exercised, or been called upon to exercise, the power of altering the general law operating—whatever that law might be—applicable to these particular hereditaments. Anything that would create an anomaly in rating was most strongly objected to by the Local Government Board.

Sir H. JEKYLL: The immediate question is whether it would be desirable or permissible to alter the general law, or to make any variation in the general law of rating on an extension of time Order. I doubt whether the Board would be disposed to entertain such an application to this particular kind of Order, or whether the remedy might not be sought elsewhere.

Mr. EDWARDS said they were not asking for any alteration, but that a particular Act should not apply in the special circumstances of this case. There was the fullest power by clause 12 to shut out any railway Act or any general enactment relating to a railway that they liked, and he submitted it was asking no more for them to say that this should be shut out under the special circumstances; they were asking no more than if they were asking that the Workmen's Trains Act should not apply. Obviously there was authority to do that. They had authority to shut out quite a number of the general railway and canal regulations, and they had exercised that power as to certain of those Acts. This was quite in the nature of a new Order, and they had the power to impose any conditions they liked. If the clause could not be inserted, he hoped the Board would take time to consider the matter with a view to seeing whether something could not be done.

Sir H. JEKYLL: I have considerable sympathy with your point of view, and I will report the whole question to the Board of Trade for their full consideration; but my personal opinion is that they will not feel themselves able to insert the clause which you desire in an extension of time Order.

PROPOSED TRAMWAY IN NANKIN.—Mr. Wilbur T. Gracey, vice-consul of the United States at Nankin, China, reports that he has recently been in consultation with the viceroy of the Liang-kiang provinces as to the advisability of constructing an electric or other tramway in the city of Nankin. All steamers coming to the city at present have to anchor at Hsiakuan, a small village on the river bank, about half-a-mile outside the city wall, and five or more miles from the crowded business portion of the city. Within the last few years a well-made macadamised road has been completed, over nine miles in length, but the only means of transportation is by donkeys, horses, jinrickshas, or very poor and expensive carriages. Chinese desiring to leave Nankin for Shanghai, or *vice versa*, are obliged to spend more for their transportation from Nankin to Hsiakuan than for the thirty-six hours' steamship journey from Hsiakuan to Shanghai. The viceroy doubts that an electric line could be made to pay, but he seems impressed with the idea of tramcars drawn by Chinese ponies, which can be purchased very cheaply. Mr. Gracey requests that the matter be placed before such manufacturers as may be interested. The population of Nankin is about 300,000, and the vice-consul considers that a properly conducted tramway under American management would pay. Five years ago there were practically no roads in Nankin. Now many good roads have been completed and others are in process of construction.

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PERSONAL.

Mr. A. Clough, Liverpool borough electrical engineer, has been granted an increase of salary from £800 to £900 a year.

Mr. Ernest Hatton, general manager of the Newcastle Tramways, has joined the committee of the Electric Tramway and Railway Exhibition.

Mr. Charles W. Mallins, traffic superintendent of Liverpool Corporation Tramways, has been granted an increase of salary from £400 to £500 per annum.

Mr. W. E. J. Heenan, Southend borough electrical engineer, has resigned that position in order to take up a similar appointment at Bermondsey.

Mr. C. R. Bellamy, general manager of the Liverpool Corporation Tramways, has received an increase of salary to £1,500 per annum, his former salary being £1,200 per annum.

Mr. R. B. H. Cragg, formerly of the Central London Railway, has been appointed assistant engineer on the staff of Mr. J. K. Robinson, agent for the American Westinghouse Company, at Iquique, Chili.

Mr. A. L. C. Fell, chief officer of the London County Council Tramways, arrived at New York a few days ago. He will sail for Liverpool on the "Cedric" on May 19, and is due in London on May 28.

Mr. T. P. Easten, who has been acting manager of the Newcastle Corporation Tramways in the interim between Mr. le Rossignol's resignation and Mr. Hatton's appointment, has been voted an honorarium of fifty guineas by the Tramways Committee.

Mr. V. G. Lironi, electrical and permanent way engineer of Portsmouth Corporation Tramways, is to have his salary increased forthwith from £250 to £300 per annum, and subsequently to £400 a year by four annual increments of £25 each.

Mr. W. J. Vincent, shift engineer at the Portsmouth Corporation power-station at Fratton, was recently the recipient of a handsome marble clock presented, on the occasion of his marriage, by the staff of the station. Mr. F. Gibson, the station superintendent, made the presentation on behalf of the staff.

Mr. J. F. Poynter has resigned his position as traveller for the London Supply Department of the British Thomson-Houston Company. He has established the firm of Poynter and Sons, at 52, Queen Victoria Street, E.C., as electrical factors and agents. They will be glad to receive price lists and terms from manufacturers of motors, fans, arc lamps, accessories, etc.

Mr. Arthur Jacob, who was lately manager of the British Schuckert Electric Company, has entered the services of Siemens Brothers and Company, Limited, the transfer of the business of the British Schuckert Electric Company to Messrs. Siemens Brothers and Company having now been completed. Further communications for Mr. Jacob should be addressed to York Mansions, York Street, Westminster, S.W.

Yarmouth.—In connection with the old Gorleston and Southtown horse tramways being superseded by an electric system, a dinner was given by a number of gentlemen on April 12 to the employees of the Gorleston and Yarmouth Tramways. Complimentary speeches were delivered by Mr. J. T. Waters (the chairman) and others, and Mr. S. Turner replied for the men. Mr. Groves, the late manager, was presented with a pair of handsome bronzes by the employees. Mr. Groves, in his reply, expressed regret at leaving Yarmouth, but said he had determined to remain in the service of the British Electric Traction Company.

Southampton Tramways Managership.—Mr. H. F. Street, the borough electrical engineer, has been appointed tramway manager for 12 months, in addition to carrying on his present duties. As briefly reported in previous issues, the Committee had some 60 applications for the post, and their choice had fallen on Mr. H. E. Yerbury, chief electrical engineer and deputy manager of the Sheffield Corporation Tramways. Alderman Dunsford therefore proposed his appointment at the meeting of the Council on April 12. This was met by an amendment that the subject be deferred for another 12 months, but on a division being taken the amendment was negatived. It was next moved that the borough electrical engineer be appointed general manager of the tramways department, as mentioned above, and this was carried by a large majority.

Mr. T. B. Holliday, who retired in the end of April from the managership of the Brighton Corporation Tramways in order to take up the position of general manager to the Hastings and District Tramways Company, was on April 23 the recipient of a handsome silver bowl, the presentation taking place at the tramways depôt, and being very numerously attended. The proceedings were marked by the utmost enthusiasm and unanimity not untinged with regret, for during his connection with the Brighton Tramways Mr. Holliday has earned the regard and respect of all with whom he came into contact. Although naturally handicapped by heavy gradients existing on every route save one, Brighton has been singularly free from accidents, owing, no doubt, to the careful supervision of Mr. Holliday, public safety having invariably been the first consideration.

Rearrangement of Glasgow Tramways Staff. The Glasgow Corporation Tramways Committee has agreed to recommend the Corporation to make the following changes in the staff consequent on the appointment of Mr. James Dalrymple as general manager, and the resignations of Mr. Charles A. King, permanent way engineer, and Mr. Matthew A. Bell, accountant: Mr. John Ferguson, chief mechanical engineer, to be appointed chief engineer, and, in addition to his present duties, to be responsible for the whole of the work formerly carried out by Mr. King; Mr. James N. Wilson, general manager's secretary, to be appointed secretary to the department; Mr. Robert F. Smith, cashier, to be appointed accountant to the department in room of Mr. Bell, resigned; Mr. Wm. Smeaton, chief purchasing clerk, to be appointed cashier in room of Mr. Smith; and Mr. A. C. Macdougall, chief storekeeper, to be appointed chief purchasing clerk, in room of Mr. Smeaton. The salaries of these and other members of the staff are to be increased, but the total annual saving to the Corporation by the rearrangement of duties will amount to £886.

Mr. E. Hatton's introduction to his new office of general manager of Newcastle Corporation Tramways was marked by two entertainments to the tramway employees given by the Mayor and the Mayoress (Alderman and Mrs. J. B. Ellis). At the first gathering a large number of town councillors and their friends attended, and Mr Hatton was also present. After tea came a concert and speeches. The Mayor said that after many trials and difficulties in connection with the tramways, they were now starting on a new era. They had had to reduce the staff and discharge a number of men. That had been very painful to the Tramways Committee, but if they had gone on as they were doing a year ago, he would have had to face the Council shortly with a deficit that would have wrecked municipalisation. Instead of that, he would face the Council with a credit balance. He introduced Mr. Hatton to the men and said that gentleman came with a reputation and a determination to work. Mr. Hatton, in his reply, hoped they would all work together to make the tramways a success. On April 15 Mr. Hatton was the recipient of a number of presentations from the Salford Corporation Tramway employees. These included a gold watch from the motor men, a kit travelling bag from the overhead equipment staff, a Chippendale clock from the permanent way staff, a silver inkstand from the inspectors, and a spirit cabinet from the office staff.

Mr. Walter Paton, who was for so many years convener of the Glasgow Corporation Tramways Committee, received special honour at a large gathering of prominent citizens held in the Glasgow Corporation banqueting hall on April 14, when a portrait of Mr. Paton, painted for the subscribers by Mr. R. C. Crawford, was presented to the Corporation in recognition of Mr. Paton's long and valued services to the city. A replica, accompanied by a watch and diamond pendant, was presented to Mrs. Paton. The Lord Provost of Glasgow (Sir J. U. Primrose), in unveiling the principal portrait, made some happy remarks in regard to Mr. Paton's services, and described him as a rugged honest Scotsman, endowed with a very abundant capital of natural sagacity and common-sense. In the matter of the tramways, Mr. Paton had laboured in season and out of season to ensure that in a municipal advance so momentous no lack of foresight on the part of the Council should jeopardise the success of the undertaking. Mr. Bilsland acknowledged the gift, and said it would form a noble addition to the attractions of the Kelvingrove Art Galleries. Dr. Robert Gourlay, in presenting the replica to Mrs. Paton, said that Dr. Paton's name would go down to posterity as the mainspring of one of the most successful of Glasgow's municipal enterprises. Mr. Paton, in acknowledging, said that during the time he was in the Town Council whatever the Council gave him to do he might fairly say he had done it with all his might. All the enthusiasm of which he was capable he brought to bear on his public work, and if he had erred it was certainly not from indisposition to do right, but from error of judgment. He had been much indebted to the Council for the way they had always backed him up in the recommendations made by the Tramways Committee and himself. The London County Council had said the other day that, unfortunately, they could not follow Glasgow by adopting the trolley system, as they had already adopted the conduit system. If they had acted as Glasgow had done he believed that the ratepayers of London would have saved a large amount of capital and annual expenditure. Further, he was perfectly certain that the London tramways would have been better, and would have yielded a great deal more to the community. He held that the trolley had come to stay, and that of all the forms of traction at present in vogue the trolley was undoubtedly the cheapest and most effective.

A Good Lifeguard Wanted in Vienna.—The Consul-General of the United States reports that no tramcar fenders are used by the street-car company in Vienna. The Vienna Street Car Company some time ago instituted a competitive trial of safety devices, and received no less than 852 designs, of which, however, only 16 were considered to be worth testing. These 16 devices were lately subjected to a thorough trial, and not one of them was found adequate.

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CONTRACTS AND ORDERS.

Thermit, Limited, have secured the contract for welding the rails on the Lanarkshire Tramway Company's extension to Larkhall.

Rochdale Corporation have accepted the tender of Bruce, Peebles, and Company for three 120 KW. motor converters.

Messrs. Thomas Noakes and Son, of Osborn Place, London, E., have received an order for 32 Hewer's patent section insulators for Leith Corporation Tramways.

The British Westinghouse Company have received an order from the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board for five tramway cars.

Croydon Corporation have accepted the tender of Callender's Cable and Construction Company, Limited, for the supply of cables for the next twelve months.

The Manchester Corporation Tramways has placed the annual contract for the supply of overhead line fittings with Messrs. S. Dixon and Son, of Leeds.

The Tidswell's Patent Automatic Tramcar Guard Company have secured the order for the equipment of the new cars on the Stockport and the Ballarat Tramways with their "trigger" lifeguard.

Northampton Corporation have accepted the tender of Messrs. Dick, Kerr and Company at £520 per car for the two additional tramcars required by the Council. The cars are to be completed as early as possible.

Raworth's Traction Patents, Limited, have received orders from Plymouth Corporation for six tramway cars equipped with Raworth's regenerative control, and from the Scarborough Tramways Company for four cars similarly equipped.

Messrs. H. Lotery and Company, 4 to 8, St. Mary Street, London, N.E., report that they have received orders for the supply of the whole of the uniforms for the second year in succession for the Middleton Electric Tramways, and for Merthyr Electric Tramways.

Hudson and Bowring, Limited, of Manchester, have received through the Brush Company the following orders for lifeguards: Belfast Corporation Tramways, 170 cars; Leith Corporation Tramways, 15 cars.

Bolton Tramways Committee have accepted tenders for the supply of stores during the year from the General Electric Company, the Robertson Electric Lamp Company, the Bolton Corporation Fittings Department, R. W. Blackwell and Company, and the Electric Tramways Equipment Company.

New Cars for Birmingham.—The Tramways Committee of the Birmingham Corporation have accepted the tender of Dick, Kerr and Company for 200 completely equipped electric cars. This is the largest order for cars which has been placed since the London County Council ordered 200 cars in April, 1903, for their New Cross, etc., lines.

Messrs. Gawthorp and Company, St. George's Sign Works, Leeds, have received an order from the Great Northern Railway Company for one special large departure indicator, for the bridge at King's Cross Station, also for the late arrival indicator. These indicators, being found so simple and serviceable, are taking a firm hold on the market.

Derby Corporation have accepted the tender of the Brush Electrical Engineering Company, Limited, for four tramcars at £2,504. The Council have confirmed the Tramways Committee's acceptance of the tender of Messrs. W. Griffiths and Company for the construction of the permanent way and electrical equipment of the tramway extensions at £18,689.

Leith Tramways Committee have accepted the tender by the British Insulated and Helsby Cable Company for the grooved wire required in the overhead installation for the new tramway system, and the tender by Messrs. S. Dixon and Son for the fittings to be used in connection with the wire. The contract price of the wire is £1,195, and the price of the fittings £894.

The Atlas Car and Manufacturing Company, of Cleveland, Ohio, inform us that they are frequently in the market for electric, oil, and gasoline locomotives for handling industrial and mining railway cars, of from 2 to 10 tons capacity, the gauges being 20, 24, 36, and 48 in. respectively. Manufacturers of locomotives of this description might find it useful to send catalogues, etc., to the Atlas Car and Manufacturing Company.

The Continuous Rail Joint Company, 20, King William Street, London, E.C., are now executing orders for their patent tramrail joints amounting to upwards of 750 tons, destined for various tramway companies, including the Dundee, Broughty Ferry and District Company, the Dartford, the Bournemouth and the Derby Corporation Tramways extensions. The Continuous Rail Joint Company announce that they can make early deliveries of continuous rail joints for any of the British standard tramrails, having complete set of rolls for each section in stock.

The J. G. Brill Company, Philadelphia and London, have recently received an order for 200 car bodies of the semi-convertible type from the Chicago City Railway Company. The amount of the contract is said to be approximately £120,000, and the whole of the order is to be completed in June. The cars will be 32 ft. 5 in. in length over the body, and will have platforms 6 ft. 2 in. in length. They will have several novel features, and appear to be an improvement on the cars which the Chicago City Railway has hitherto provided for the public. The suggested municipalisation of the tramways has apparently aroused the company to unwonted activity, for it is reported that an expert inspection of their entire system, including track, rolling stock, and car depôts is being made. As a result it is expected "that in a short time the service will be such as will satisfy the highest expectations."

Johannesburg Town Council have accepted the tender of Messrs. Dick, Kerr and Company for 100 electric tramway cars and two watering cars, with accessories. Their price f.o.b. English shipping port, *plus* erection on site, amounts to £65,693, and for the transit cost £16,624. The price per car is: Class "A" car, £594, delivered English shipping port—£47,520 for eighty cars; class "B" car, £575, delivered English shipping port—£11,500 for twenty cars; total £59,020. The difference between £65,693 and £59,020, namely, £6,673 is the f.o.b. English price of the two watering cars, tools, spares, etc. If canopies are required for some of the class "A" cars, the cost to be £127 extra per car. The Council have accepted Messrs. Dick, Kerr's tender, subject to the substitution of their own type of magnetic track and wheel brake for the Westinghouse brake. The Council has also agreed that Messrs. Mordey and Dawbarn be authorised to accept Messrs. Dick, Kerr and Company's tender for transit charges, amounting to £16,624, provided that they are satisfied that it will be to the advantage of the Council to accept this tender, and that the twenty cars of class "A" first supplied be provided with canopies at an additional cost of £127 per car.

South Shields Tramway Contracts.—Out of 29 tenders for the construction of the permanent way and track of the new tramway system at South Shields (part 1) the Tramways Committee selected that of Messrs. William Underwood and Brothers, Dukinfield, amounting to £42,903. The tender of the same firm for the construction of copper rail bonds and the bonding of tramways (part 2) for £770 was also accepted. The Electrical Committee have recommended the acceptance of the tender of Messrs. Dick, Kerr and Company, amounting to £2,695, for generators; also the tender of £8,400 of Messrs. J. and H. McLaren, of Leeds, for engines. Messrs. Dick, Kerr and Company's tender for conduits, cables, and overhead equipment, amounting to £12,321, has been accepted. Other tenders provisionally accepted were: Ten electric tramcars with "Brill" trucks, Messrs. Hurst, Nelson, and Company, £5,307; boiler, Messrs. J. T. Eltringham and Company, South Shields, £1,365; switchboard, Messrs. British Thomson-Houston Company, £665; pumps, foundations, etc., £2,500. The total amount of the various contracts is £76,928, and altogether 122 tenders were received. The Town Council confirmed the recommendations except that for cars, objection being taken in the interests of British industry to the Brill trucks. This matter was referred back for further consideration.

Dundee and Broughty Tramways.—The contract for the construction of the Dundee and Broughty Ferry and District tramways has been placed with Messrs. J. G. White and Company, of London. The contract price for the work amounts to £80,250, which sum includes the cost of the permanent way, overhead equipment, power-station, car sheds, cars, and the construction of a street through the lands of Craigie. There are 5¼ miles of route, equivalent to 9¾ miles single track. The gauge is standard. The rails are British standard No. 1, 45 ft. long, fitted with continuous rail joints and intermediate anchors. The points are 10 ft. 6 in., having a radius of 100 ft. Crossings are iron-bound. One mile of the track will run on a new road through the Craigie and Home estates. This portion of the track will be laid with the usual 6 in bed of concrete, and paved with tar macadam and granite edging. The bridge over the Dighty will be widened. The overhead construction will consist mostly of bracket arms; there will be double trolley wire 2-0 B.S. at a height from the ground of 21 ft. Cables are to be laid on the solid system. The power-house will be a brick building with a chimney shaft of 110 ft. The plant will consist of two 200 KW. railway generators with high speed engines. There will be three Lancashire boilers, superheaters, and the usual condensing plant. The car shed will be a brick building 175 ft. long, and 45 ft. wide. The tracks in the car shed will consist of vignoles rails laid on sleepers. There will be twelve single truck double-decked cars, fitted with two 37 H.P. motors. Messrs. J. G. White and Company propose to break the ground within a few weeks, and about the same time they will commence the construction of the Dartford tramways, to which we have already referred. These two contracts are similar with regard to length of track, construction, and equipment.

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FINANCIAL REPORTS.

Coventry Electric Tramways Company recommend a dividend of 2 per cent. for the year 1904, transferring £500 to reserve, and leaving £646 to be carried forward.

Anglo-Argentine Tramways Company.—The net profits for 1904 were £174,003. The directors recommend a final dividend of 5s. per share on the ordinary shares, which, with the 3s. per share paid in October last, will make 8s. per share or 8 per cent. for the year; a balance of £5,922 3s. 6d. to be carried forward.

Dover Corporation Tramways.—The tramway receipts for the year ending March 31 were £11,177 9s. as compared with £11,265 8s. 7d. for the previous year. The Harbour Board are paying £73 8s. compensation for loss of revenue owing to the delays caused by the construction of the Prince of Wales Pier Railway, which brings the deficit on the receipts of 1903-4 down to £15.

Calcutta Tramways Company.—For the year 1904 the gross traffic receipts were £127,780, working expenditure under all heads £64,553, and a revenue balance, after crediting sundry receipts, £63,513. The directors recommend a final dividend of 5s. per share, which, with the interim dividend paid in October, gives a return of 8 per cent. for the year; a balance of £1,576 to be carried forward.

Meldrum Brothers, Limited.—The accounts for the year 1904 show an available balance of £6,224, out of which 4 per cent. has been paid on the ordinary shares, and a further distribution of like amount is now proposed, leaving £1,326 to be carried forward. It has been decided to offer a limited number of ordinary shares to the preference shareholders at 5s. per share premium, which premium is to be placed to reserve.

Derbyshire Motor-Omnibus Company, Limited.—This company was registered on April 18, with a capital of £5,000 in £1 shares. Object, to run a service of motor-cars or omnibuses for the conveyance of passengers and goods between Baslow, Grindleford, and Bakewell, and to carry on the business of motor car and omnibus proprietors, etc. Registered office: Alliance Chambers, George Street, Sheffield.

Potteries Electric Traction Company.—Net profits for 1904 amounted to £26,705, and the disposable balance is £27,471. The directors recommend a dividend at the rate of 5 per cent. for the year, and transfer £2,500 to depreciation and reserve fund, leaving £471 to be carried forward. The report states that it has been decided to test the traffic possibilities of routes beyond the existing tramways and light railways by means of motor omnibuses.

Blackpool Corporation Tramways.—The electrical engineer, Mr. C. Furness, estimates that out of profits on the electric lighting and tramways departments the rates of the town will be relieved to the extent of £5,000, which has been made possible through economy in coal, equal to nearly £3,000, together with an increased output The Corporation tramways have increased their receipts by £6,468, the number of passengers being 890,161, and miles run 103 352.

Huddersfield Corporation Tramways, with a capital of £414,667 last year, brought in a revenue of £69,938. The working expenses were £35,084, and the gross surplus, £34,853. Interest and redemption takes £23,343, and the surplus is £11,510, but the depreciation is £12,013 at 3 per cent., leaving an adverse balance of £500. It is proposed to levy a rate of 3¼d. in the pound to wipe off this and a deficiency brought forward from the previous year of £4,481. There was a deficiency in 1901 of £10,100. In 1903 the rate in aid was 7d. in the pound, and the last year 5d.

Halifax Corporation Tramways.—A statement of receipts for passenger and parcel traffic during the past year has been prepared. The receipts amounted to £74,019, or 11·53d. per car mile, the aggregate number of car miles run being 1,540,707. In the previous year the receipts were £68,208, or 11·79d. per car mile run. The present length of route open is 35½ miles, which is 2½ miles more than twelve months ago. The current consumed during the year amounted to 3,009,940 units, or 1·94 units per car mile, compared with 1·87 units per car mile in the year of 1903-4.

Merthyr Electric Traction and Lighting Company.—The report for 1904 states that the gross tramway receipts amounted to £10,631, and the gross receipts on account of electrical supply to £3,775, making, with £55 sundry receipts, a total of £14,460. After deducting expenses amounting to £12,345, and adding the balance brought forward, £187, there remains £2,301 available for distribution The directors recommend that this should be applied as follows: To reserve and depreciation fund, £500, and dividend on preference shares to December 31, 1904, £1,500, leaving £301 to be carried forward.

Bath Electric Tramways.—The report for 1904 shows a capital expenditure of £302,545. The traffic receipts amounted to £33,161. After charging operating and administration expenses, there remains a balance of £11,250, from which must be deducted interest accrued on the four-and-a-half per cent. debenture stock £737, and dividend on the preference shares to December 31, 1903, paid December 29, 1904, leaving a balance of £7,670. Out of this the directors recommend the payment of a dividend at the rate of 5 per cent. per annum upon the preference shares to December 31, 1904, which will absorb a sum of £3,750, leaving to be carried forward £3,920.

Brush Electrical Engineering Company, Limited.—The report for 1904 shows a gross profit of £71,280. General charges, maintenance, interest on debenture stock, and £6,500 carried to depreciation reserve fund absorb £43,200, leaving a net profit of £28,080. The directors recommend a dividend of 6 per cent. per annum on preference shares for the year, placing to general reserve fund £7,000, and carrying forward £3,080. The depreciation reserve fund will then stand at £45,107, and the general reserve fund at £16,450. A sum of £11,508 has been expended on additions to plant and buildings during the year.

Barcelona Tramways.—The balance at the credit of revenue account for 1904, after adding £3,940 received from the Ensanche Company and the £1,502 from the previous account, is £46,232. Of this sum the interest and sinking funds of the debentures and of the debenture stock have absorbed £16,600, interest on loans £723, and the dividend on the preference shares £5,000. The directors have placed a further sum of £10,000 to renewal fund, raising that fund to £17,000, and they now recommend the payment of a dividend on the ordinary shares at the rate of 6 per cent. per annum (12s. per share), free of income-tax, and that the sum of £2,529 be carried forward to next account.

Auckland Electric Tramways.—After deducting all expenses chargeable to revenue, including £12,234 for debenture and other interest, £2,521 for rental and percentage of profits payable to the Auckland City Council, and £4,658 balance of expenditure in connection with the Kingsland accident, there remains a profit of £26,275, which added to the amount of £2,322 brought forward from the previous account, makes an amount of £28,598 available for distribution. This the Directors recommend should be applied as follows: amount to be reserved to meet depreciation, £7,500; to pay a dividend at the rate of 6 per cent. per annum on the share capital, £18,000; and balance to be carried forward, £3,098.

Leeds Tramways.—In our issue of April 6 we gave a summary of the Leeds tramway receipts for the year ended March 25, but since then the full balance sheet has been prepared, and it appears that the receipts will not fall below £56,000, after allowing for depreciation and sinking fund charges. A year ago £52,000 was appropriated to the relief of the rates, and Mr. R. A. Smithson, the chairman of the Tramways Committee, predicted that with a continuance of the policy previously pursued the profits for the year would be at least £55,000. This estimate was sharply criticised as too optimistic at the time, but the result has fully substantiated Mr. Smithson's forecast.

Rochdale Corporation Tramways.—The financial results for the twelve months ended March 31 shows a loss of £8,358. On the revenue account the income for the year amounted to £14,975 3s. 7d., while the working expenses were £12,770. Thus on the working account alone there is a profit of £2,205 3s. 7d. Against this, however, there has to be charged for interest on capital £8,868, sinking fund £1,744, and other items which make a total of £10,853, which, after deducting the profit on working accounts, leaves the deficiency of £8,358. Only three of the minor sections have been working the whole of the year, and some of the more important sections have only been working three and six months.

Raymond-Phillips Electric Railway and Tramway Equipment Company, Limited.—This company was registered on April 1, with a capital of £10,000 in £1 shares. Object, to acquire any patents and rights relating to improvements in connection with overhead electric wires for railways, tramways, and screws; in particular, to acquire from T. E. R. Phillips the benefit of certain existing inventions relating (1) to an improved construction of mechanical ear for electric trolley wires or the like; (2) to an improved construction of section insulator for electric trolley wires or the like; (3) to an improved construction of splicing ear for electric trolley wires or the like; and (4) to improvements in connection with screws, and to develop and turn to account the same.

City of Birmingham Tramways Company, Limited.—The report for the year ending December 31 last shows a total revenue of £293,958, and an expenditure of £209,532, leaving a balance of £84,426. To this must be added balance brought forward from last year, £2,083, making a total of £86,509. After paying interest on debentures, £12,000, and dividend on preference shares, £12,083, and deducting the sum of £2,104, being the interim dividend paid for the half-year ended June 30 last, a balance available for distribution is left of £60,321. Out of this the directors recommend the payment of a dividend on the ordinary shares at the rate of 5 per cent. per annum, together with a bonus of 5 per cent., making 10 per cent. for the year. This will amount to £6,314, and it is recommended that the balance of £54,007 be carried to the reserve fund to provide for depreciation, etc.

Thomas Tilling, Limited.—The report for 1904 shows a profit on the year's trading of £42,755. After providing for the interest on

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debentures and new preference shares issue expenses, and deducting the interim dividend on preference shares paid July 1, 1904, there remains a balance of £32,591. Of this, £8,530 was paid to the preference shareholders on January 1 last, and of the remainder the directors recommend that £1,500 be transferred to the reserve fund, thereby raising it to £16,000; that a sum of £5,000 be appropriated to a premises conversion account, and that a dividend of 10 per cent. be paid on the ordinary shares, leaving £27,161 to be carried forward. The directors are satisfied with the experiments made in relation to motor omnibuses during the past year, and have placed orders for the delivery of a number of these vehicles. The cost of the experiments has been borne out of revenue, so as to keep intact the sum of £1,000 set aside for this object. The employment of motor vehicles compels alteration to some of the premises, and in order to provide for this the directors recommend that out of the past year's profits £5,000 be appropriated to a premises conversion account.

Bradford Corporation Tramways. A statement of the working of the Bradford Corporation Tramways for the financial year ended on the 25th ult., shows that the total number of passengers carried was 47,108,000, as against 39,639,414 during the previous year, an increase of 7,468,586, or 18·84 per cent. The total receipts have been £228,648, as compared with £197,437, being an increase on 1903 of £31,211, or 15·81 per cent. The difference in percentage is accounted for by the preponderance of penny fares caused by the number of passengers travelling from the city to the Exhibition. There has been an increase of 493,510, or 10·85 per cent., in the number of car miles run, and the revenue per car mile has been 10·88d., as compared with 10·421d. last year, or an increase of ·459. The total number of cars is 239, and the population served by the various tramway routes is 324,000, which number has been carried no fewer than 145 times. The increase in the receipts is accounted for in various ways, chiefly the fine weather which was experienced during last summer, the taking over of the Shipley trams, and the Exhibition, on the opening day of which no less than £1,400 was received.

Dundee, Broughty Ferry, and District Tramways. This company has been formed, the prospectus states, to carry on the construction and equipment of the tramways and tramroads and other works authorised by the Dundee, Broughty Ferry, and District Tramways Order Confirmation Act, 1904. The total population served by the company's lines will, exclusive of summer visitors, exceed 177,000. In a report as to the probable earnings of the authorised tramways, Mr. Stephen Sellon, M.Inst.C.E., estimates that the gross income will be £22,137, yielding a net revenue of £10,085. "These figures," Mr. Sellon reports, "correspond to carrying the whole population of the district served twenty times per annum at an average fare of 1·5d. per passenger, and represents an earning capacity per route mile equal to results obtained on other lines in similar districts within my experience. On the basis of an average service of 7½ minutes during fourteen hours per day and at 11d. per car mile the gross income would be £20,570, and with a working expenditure of 6d. per car mile the net income would be £9,350. The figures of earnings and expenditure are well within results on similar systems." Subscriptions were recently invited and received for £40,000 5 per cent. mortgage debenture stock, 50,000 6 per cent. cumulative preference shares, and 15,000 ordinary shares of the Dundee, Broughty Ferry, and District Tramways Company Limited.

The Yorkshire (West Riding) Electric Tramways Company, Limited, through their bankers, Messrs. Glyn, Mills, Currie and Company, have invited subscriptions for £275,000 4½ per cent. first debenture stock at 95 per cent. The stock will be redeemable at 105 at any time after the expiration of ten years from January, 1905, at the option of the company, or in the event of voluntary liquidation. The stock will constitute a first charge upon the assets of the company, the importance of whose undertaking is well known to tramway men. Mr. V. B. D. Cooper, Assoc.M.Inst.C.E., M.I.E.E., the consulting engineer, in his report to the directors states that the sixty miles of single-track tramways and light railways to be constructed will serve the towns and districts of Leeds, Wakefield, Horbury, Ossett, Rothwell, Normanton, Castleford, Pontefract and Knottingley. The roads being suitable in every way, a good average speed can be maintained. The power-station will be served by the Calder Navigation. Mr. Cooper estimates the total cost of the sixty miles at £715,000, of which £435,000 has already been spent on the lines that were opened last autumn. An authorised extension by the local authorities will be a valuable feeder, as it will connect the British Electric Traction lines and the important towns of Dewsbury, Batley, etc., with this system. The consulting engineer estimates that the net earnings of the entire sixty miles will amount to £57,000 a year. The working expenses on the lines already opened amount to 52·8 per cent. of the gross earnings, during an unfavourable season of the year, and while some initial difficulties had to be overcome.

Metropolitan Electric Tramways, Limited. The report for the year ended December 31 last states that the total revenue amounted to £113,254, including the dividends on shares held in the North Metropolitan Tramways Company and the Harrow Road and Paddington Tramways Company, and interest upon the advances made to the North Metropolitan Electric Power Supply Company. The gross traffic receipts amounted to £81,843, as compared with £66,973 for the previous year. As the lines now working by electric traction were not opened until the second half of the year, and some of them not until December, the directors consider the increase of traffic receipts satisfactory. The revenue account, after deducting all expenses chargeable to revenue, including loan and debenture interest, shows a surplus of £32,283. Deducting the full dividend on the preference shares for the year, amounting to £25,000, and providing for the repayment to the British Electric Traction Company, of the balance due to them for the advance made in January, 1903, under their guarantee of the preference share dividend, there remains an available balance of £3,854, which the directors recommend should be carried forward. The directors propose to make an issue of ordinary shares at par to the holders of all classes of shares and to the debenture stockholders on the registers on the 7th inst. in the proportion, as nearly as practicable, of one ordinary share in respect of every ten shares or £10 debenture stock held at that date. It is proposed to make the shares payable by instalments of 5s. on acceptance of allotment, 5s. one month later, and 10s. two months later.

Greenock and Port-Glasgow Tramways Company, Limited.—The report for the year ended December 31, 1904, states that the outlay on the electrical construction account during the year amounted to £5,365, and that £3,787 had been debited for material transferred from outlay on old lines, making the total expenditure £186,034. The total revenue was £30,583 and the expenditure £21,359, which sum included interest, rentals payable to Corporation, cost of repairs and maintenance, and a provision of £1,500 for depreciation and renewals, leaving a profit of £9,224. To this had to be added £2,093 brought forward from last account, making a total of £11,317, which the directors recommend should be applied as follows: For the reserve (sinking) fund, £1,780; dividend at the rate of 5 per cent. per annum on the preference shares, £3,500; dividend at the rate of 4 per cent. per annum on the ordinary shares, £4,600; balance to be carried forward, £1,437. The reserve (sinking) fund will then stand at £5,448. The claim in respect to profits by the Greenock Corporation referred to at the last general meeting was inquired into in November last by the inquirer appointed by the Board of Trade, whose report had since been made, recommending the Board of Trade to award that the sum of £603 is due to the Corporation to December 31, 1902. The directors, however, took exception to certain parts of the report, and had requested the Board of Trade to state a case for the decision of the High Court on points of law. Six additional cars had been purchased during the year, making a total of 36. The number of passengers carried during the year was 6,644,388, as compared with 6,200,778 in 1903. The average receipts per passenger were 1·08d., as against 1·13d. the previous year. The average working expenditure per passenger (apart from rentals, etc.) was ·62d. against ·57d.

Gloucester Tramway Results.—The first annual report of the Light Railways Committee of the city of Gloucester, covering the period from April 29, 1904, to March 31, 1905, has been issued under the signature of the chairman, Mr. Ralph Fream. The result of the eleven months' working shows that the revenue amounted to £13,668, and after payment of working expenses (£9,741) and interest on capital and sinking fund, the net balance amounts to £245, which has been carried to next year's account. The following are among the particulars compiled in accordance with the Municipal Tramway Association's standard form of accounts:

Car miles	449,320
Passengers carried	3,546,852
Power—Total number of units consumed	517,257
,, ,, ,, ,, at Depot	12,076
,, Average number of units consumed per car mile ...	1·15
Average number of cars in use per 14·5 hours day... ...	16
Percentage of operating expenses to receipts	70 per cent.
Average traffic revenue per car mile	7·22d.
Average traffic revenue per mile of single track	£900 18s. 2
Average total revenue per car mile	7·43d.
Average car miles per day per car	83·33 miles
Average speed per hour	6·5 miles
Maximum speed allowed by Board of Trade	12 miles
Average operating expenses per car mile, excluding power cost	3·77d.
Average operating expenses per car mile, including total power cost	5·20d.
Percentage of ½d. fares to total traffic revenue	20·57 per cent.
,, 1d. ,, ,, ,, ...	49·67 ,,
,, 1½d. ,, ,, ,, ...	7·48 ,,
,, 2d. ,, ,, ,, ...	18·64 ,,
,, other fares ,, ,, ...	3·64 ,,
Average distance travelled per passenger	·126 of a mile
,, fare paid per passenger	·913d.
,, operating expenses per passenger...	·659d.
,, number of passengers carried per car mile ...	8
Maximum number of passengers carried on any one day	34,028
,, traffic receipts on any one day	£166 12s. 4d.
Average journeys per head of population for period of 11 months	71
Number of cars in stock	39

The accounts are signed by Messrs. A. B. Clutterbuck, city accountant; Percy P. Gutteridge, light railways accountant; and E. Edwards, general manager, and they have been audited by professional auditors appointed by the Council.

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TRAMWAY & LIGHT RAILWAY NOTES.

BLACKPOOL.—The new promenade tramway between the North and Central Piers was opened in the latter part of April. This section consists of a double line between the North and the Central Piers, some 1,200 yards in length. The whole of the work has been completed in about five weeks' time.

BOURNEMOUTH. The terminal lines of the Bournemouth and Poole tramways have now been joined up, and through running will commence as soon as the transfer is legally completed of the Poole and District Electric Traction Company's undertaking to the Bournemouth Corporation. The Tramways Committee have been inspecting several cars with a view to obtaining lighter cars for the traffic in the more rural districts. The surveyor has, under instructions, obtained tenders for ten cars, five of which are to be similar to the existing bogie cars, and the other five to be single deck and semi-open, two of them to be fitted with radial trucks.

BRADFORD Mr. James Hill, chairman of the Bradford Tramways Committee, speaking at a recent meeting, alluded to the agitation which had been raised in favour of halfpenny fares, and dealt effectively with the criticisms of the work of the Tramways Committee. He said he would like the Council to understand that they had an important work to do. They were carrying on one of the largest businesses in the city, and one of the most difficult, and he wished the councillors would realise that when the Committee met they did not meet to play. The members of the Committee had made up their minds that the fares were as low as they could possibly be. He expressed the opinion that the employees of the city tramways had as favourable conditions of service as any other class of men in the city, and he did not consider that the system of split turns entailed any hardship on the men.

CARDIFF. Mr. R. B. Goodyer, who was manager of the Cardiff tramways until they were taken over by the Corporation, has put in a claim for £2,500 in respect of injuries sustained by his wife, who was knocked down by an electric car in September last. Mrs. Goodyer was crossing Newport Road, near her house, when the accident happened. The Corporation are defending the action, and have instructed the town clerk to retain counsel.

CROYDON.—Interesting statistics have been compiled regarding the Croydon tramways, which, since the electrification, have been worked under lease from the Corporation by the British Electric Traction Company. During the last three years of the old horse cars 10,000,000 passengers were carried, but during the three years of the electrified system 40,000,000 have been carried. In the last twelve months the population of Croydon, about 145,000, has been carried almost one hundred times over. In one year £20,000 was absorbed in wages, while the taxes paid totalled £2,120.

DUNDEE.—The Corporation, by a majority of one vote, have decided against running the cars on Sundays.

GREENOCK.—The Corporation of Greenock and the Tramway Company have agreed on a revised scale of rates for electricity for the next five years, subject to certain conditions on the eve of settlement. The rates are as follows: First 500,000 units at 1½d. per unit, next 200,000 units at 1¼d. per unit, then 200,000 units at 1d., and anything further at ·85d. per unit. The revenue from these rates is expected to amount to about £5,000 per annum.

LANARKSHIRE. -Engineers representing the Caledonian Railway Company have been engaged in surveying operations in the Carluke and Crossford districts, and it is understood that their work is in connection with a proposed extension of the Caledonian line into the extensive fruit-producing district of Clydesdale. While principally meant for fruit traffic, it is expected that a passenger service will also be inaugurated, as the district attracts large numbers of excursionists during the summer.

LEITH.—A plebiscite of the ratepayers of Leith, on the question whether the cars should be run on Sunday, has resulted in 6,763 voting for Sunday running, and 3,616 against a majority in the affirmative of 3,147.

PONTYPRIDD AND RHONDDA. - It was decided at a meeting of the Pontypridd Electricity and Tramways Committee on April 11 that a committee should be appointed to meet the Rhondda District Council, with a view to coming to an understanding in regard to through traffic on the tramway between Hafod and Porth and on to the Upper Rhondda.

ST. HELENS – The car-shed of the St. Helens Corporation Tramways is to be the place of meeting on June 3, when Mr. Chamberlain visits St. Helens. The depôt will be converted into a comfortable and commodious hall capable of seating 7,000 persons. Considering that a larger proportion of tramway equipment than is desirable even yet comes from abroad, the place of meeting is not likely to weaken Mr. Chamberlain's arguments. -A serious strike began among the St. Helens and District Tramways Company's employees on April 26, and had not been settled when these pages went to press. The strike arose from the refusal of the company to grant them an increase of pay which the men say was promised them some time ago, but which the company say they cannot give at the present time. The service has been much disorganised, and some of the officials of the company have been employed driving the cars.

SOUTH SHIELDS.– The following recommendation of the South Shields Tramway Committee was recently adopted by the Town Council by 24 votes to six: "That as in their opinion the motor 'bus service is unreliable, the smell of petrol highly objectionable, the vibration excessive and discomforting to passengers, the shocks at periods of stopping, starting, and changing of speeds severe and objectionable; and, further, as no reliable data are available as to the working costs of the motor 'buses, owing to the very short period they have been in use, but that everything tends to show that such working costs are high, and in excess of an electric tramway service, the deputation cannot recommend the adoption of a motor 'bus service for the borough." The recommendation was made after the committee had visited various towns and inspected the motor 'buses in use there.

STOCKPORT. Work was commenced on April 13, on the construction of the tramways between Stockport and Hazel Grove, an extension of the Stockport Corporation tramways. The work was begun with a suitable ceremony, and subsequently Councillor Fernley, vice-chairman of the Tramways Committee, entertained the members of the Committee, the officials, and others at the Warren Bukeley Hotel.

SUNDERLAND.– The new tramway offices were formally opened on April 19 by Councillor Summerbell (chairman of the Tramways Committee). The cost of construction has been about £6,000, and it is intended to pay this sum out of the tramway revenue, the payment to be spread over a period of six years.

SWANSEA. The Swansea tramways extensions were opened on April 22. The new sections utilised are to Wind Street, Sketty, Brynmill, and Brynhyfryd, the St. Thomas section not yet being ready.

TYNEMOUTH.- An appeal by the Tynemouth and District Electric Traction Company against the rating of their property was heard at the Northumberland Easter Quarter Sessions at Newcastle on April 6. Sir Edward Boyle, K.C., and Mr Simey appeared for the appellants, and Mr. W. C. Ryde and Mr. Mitchell Innes were for the respondents, the Assessment Committee of the Tynemouth Union. Sir Edward Boyle in his opening statement said the tramway went into five different townships, Chirton, North Shields, Cullercoats, Tynemouth and Whitley. The property in these five townships had been re-assessed at £4,938 gross and £2,549 ratable. The Company objected and the ratable value was reduced to £1,800, and it was against that £1,800 that the appeal had reference. The following witnesses were called by the Tramway Company: William M. Rumball, surveyor to a large number of electrical undertakings; Philip M. Faraday, W. H. Elwell, and Mr. R. J. Howley, who put in values varying from £1,000 to £1,150. On behalf of the Assessment Committee, J. Hunt Hedley, W. P. Ryan and Ernest M. Lacey were called, whose values varied from £2,200 to £2,300. The bench after deliberation intimated that the value of the lines would be fixed at £1,367, which was to be apportioned to the different parishes out of sessions. Costs were allowed to the appellants.

WEMYSS. Mr. R. G. E. Wemyss has decided to float a company to carry out the proposed tramway scheme from Leven, through Wemyss, to Kirkcaldy, powers for which were granted recently. At the inquiry, Mr. Wemyss said he intended retaining the concern entirely in his own hands, but the Home Office stated that he must form a statutory company within two years, and hand over the whole concern to the company. In view of this he has decided to float the company with a share capital of £60,000 to £70,000, half preference and half ordinary, with about £20,000 of debentures. Mr. Wemyss will retain the ordinary shares in his own hands.

YORK.—At the last meeting of the Streets and Buildings Committee of the York Corporation, the question of the negotiations between the committee and the York Tramways Company as to the purchase of the undertaking came up for discussion. The last offer made by the Corporation was £9,000, to which the Tramways Company responded by asking £12,000. Since then negotiations have been conducted between the two bodies, without definite result, and it has now been decided to recommend the Council to discontinue the negotiations.

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TRADE PUBLICATIONS.

Messrs. Mather and Platt, of the Salford Iron Works, Manchester, issue the fifth edition of their useful pocket catalogue and tables. Since the last edition was published several types of machinery have been added and those are included in the 1905 issue. The tables in the latter half have also been considerably extended.

W. T. Henley's Telegraph Works Company, Limited, have issued the first part of a handsome price list of cables for electric lighting, traction, and power transmission. These cables are made single, concentric, triple-concentric, twin-core, and three-core, and for a variety of pressures up to 11,000 volts; but this catalogue deals principally with low and medium tension cables with paper insulation and lead covering, three-phase and rubber-insulated cables being treated in separate lists. The details are in accordance with the recommendations of the Engineering Standards Committee. As is apparent from the book, everything is done to secure the best possible materials and workmanship, and all cables made are subjected to severe tests before being sent out. The bulk of the catalogue is occupied by well-printed tables giving particulars and prices of the various kinds and sizes of cables, together with code words for use when ordering. The illustrations are confined to section views of cables. A marginal thumb index greatly facilitates consultation.

Brush Canopies for Tramcars.—The popularity of the top-covered car has been amply demonstrated during the present winter. A week rarely passes now without an intimation that some corporation has decided either to experiment with or to adopt outright one of the types of canopy with which we are now familiar. Public appreciation, of course, means increased earning power, and the fact that the adoption of this form of shelter sends the car-mile receipts up some 20 per cent. is an irresistible argument in its favour. The Brush Electrical Engineering Company, Limited, Falcon Works, Loughborough, with their customary enterprise, have been specially prominent in meeting the demand thus created, and have made many experiments in order to arrive at the ideal canopy. Instead, however, of ultimately deciding on a standard pattern, it has been found desirable to present a number of models which differ considerably both in design and construction, and the Brush Company are thus prepared to meet varying local conditions. Their attractively got-up catalogue illustrates and describes these various types, among which are the well-known Manchester, Leeds, Bolton, Liverpool, and Salford patterns. Fixed canopies, sliding roofs, collapsible covers, wind screens, and combinations of the above, are all portrayed here, although it is remarked that the consensus of opinion in the United Kingdom is inclined to favour the first-named.

"Steam."—Babcock and Wilcox, Limited, have just issued the fifth edition of their well-known book entitled "Steam." This new edition is larger and produced on even a finer scale than the last, and it contains much new matter in the letterpress as well as additional illustrations bringing it down to date. For the benefit of any readers who have not seen previous editions, it may be explained that the book is an ingenious blend of a treatise on steam-raising with a description of various types of boilers, and particularly of the Babcock and Wilcox boiler, together with numerous reasons why, in the opinion of the company, the Babcock and Wilcox boiler is superior to all others. While in the latter direction the book must be very effective, it also contains a series of articles and tables relating to the science and technics of the production of steam, the efficiency of boilers, the comparative value of different fuels, the value of superheaters, the effect of tall chimneys, the properties of saturated and superheated steam, and a great variety of other information of much value to all steam users, and particularly to those concerned in the working of electric generating stations. The volume is profusely illustrated both with line drawings and half-tone reproductions from photographs, the latter of which, including views of many of the principal boiler houses of electric stations in this country and abroad, are among the finest examples of this class of illustration which we have ever seen. The whole volume is beautifully got up, and to complete it we have at the end an exhaustive index which is modestly described as a table of contents.

CONDENSING PLANT.

The Mirrlees Watson Company, Limited, of Glasgow, make a special feature of the manufacture of Independent Condensing Plants having either Wet or Dry Air Pumps, and suitable for working in connection with Reciprocating Engines or giving the high vacuum desirable with Steam Turbines.

PATENT LIST.

Specially abstracted for "The Tramway and Railway World" from the Official Journal of Patents.

∴ If the inventions have been communicated the names of the communicators are given below in italics.

APPLICATIONS.

Applications for Letters Patent have been filed as follows:

6,400 Hangers for overhead electric wires—J. F. Simpson.
6,419 Method for automatically reversing direction of trolley—B. Smith.
6,455 Means for fastening ears of trolley wires—A. Rogers.
6,504 Covers for tramcar seats—J. J. Marsh.
6,523 Trolley poles—W. Williamson and J. Collinson.
6,606 Method for locking ends of rails of railways and tramways—E. B. Killen.
6,658 Manufacture of railway and tramway rails—C. P. Sandberg.
6,679 Electric railways—J. D. Lawson and T. Littlefair.
6,802 Automatic electric tramway signals—H. Storm and T. Simpson.
6,838 Suspension of overhead conductors for electric railways—B. J. Jones.
6,904 Method for preventing accident through breakage of trolley wires—G. W. Fowler and G. Hildreth.
6,945 Route indicators for tramcars—H. H. Lake.
6,958 Safety devices for overhead wires for electric traction—H. R. Burnett.
7,065 Dry seats for tramcars, etc.—G. Glossop and J. C. Skinner.
7,148, 7,149, 7,150 Electric motor control systems for electric cars—British Thomson-Houston Company (*General Electric Company*).
7,157 Regenerative control of electrically propelled vehicles—H. W. Dickinson.
7,168 Lifeguard for tramcars—W. Percy.
7,176 Method of operating points of trolley wires and of rails—J. Greenwood and Son.
7,203 System of lining railway and other tubular tunnels—A. R. Bennett and E. W. Twining.
7,293 Lifeguards for tramcars—T. F. Gillett and W. B. Hopkins.
7,360 Device for keeping trolley rope tight—J. L. Dawson, J. Clark and R. Blackmore.
7,479 Tramway cars—W. P. Michel.
7,555 Sole or anchor plates for tramway rails—T. Grey.
7,698 Manufacture of steel for railway and tramway rails—C. P. Sandberg.
7,801 Motor omnibuses—B. E. Dickinson.
7,856 Electrically propelled railway vehicles—J. P. Barker.
7,879 Trolley heads—J. W. Hancock.
7,956 Lifeguards for electrically propelled vehicles—E. A. Greaves.
8,049 Working of tramway or railway points—W. B. Docharty.
8,090 Trolleys for electric railways—A. P. Zani.
8,122 Construction of electric tramways—S. G. Bennett.
8,304 Seats and seat backs for tramcars, etc.—C. Brawn.
8,313 Outside seats of tramcars, etc.—A. Kirkham.
8,443 Trolleys of electric cars—H. Halstead, A. Johnson and S. Winn.
8,500 Seats for tramcars, etc.—W. A. Watson.
8,524 Protected third-rail system—I. C. Thorne.
8,596 Signalling on rail and tramways—C. J. Goodeve.

SPECIFICATIONS ACCEPTED.

The following applications, of which the specifications have been published, are now open to opposition by prior patentees or any other persons interested:

1904.

5,634 Switch point and frog for overhead equipment—Bonthrone.
8,244 Apparatus for placing tramcars on or removing them from rails—Jones.
9,235 Sandbox for tramcars, etc.—Shaw and Kidman.
10,812 Trolleys for electric cars—Blaney.
11,287 Route indicators for tramcars, etc.—Walker.
12,918 Machines for printing and numbering tram tickets, etc.—Middleton and Clift.
17,025 Brake-blocks for railway and tramway cars—Haddon (*Lachaud*).
18,756 Street railway cars—Goehring.
22,839 Method of supporting trolley wires—Allen.
27,209 System of electrical distribution for railways—Hallberg.

THE GLASGOW RAILWAY AND ENGINEERING COMPANY, LIMITED, of Helen Street, Govan, Glasgow, have removed their London office to 12, Victoria Street, S.W.

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TRAFFIC RETURNS.

TRAMWAYS AND OMNIBUS LINES.

NAME.	1904. WEEKS ENDING April 2.	April 9.	April 16.	April 23.	1905. WEEKS ENDING April 1.	April 8.	April 15.	April 22.	AGGREGATE. Wks.	1905.	Increase or Dec.
	£	£	£	£	£	£	£	£		£	£
Aberdeen Corporation	1,166	1,206	1,206	1,230	1,110	1,124	1,116	1,133	47	51,875	+ 5,359
Airdrie	184	199	185	207	179	194	196	195	16	3,084	8
Barcelona	1,515	2,198	1,891	1,796	2,071	2,165	2,110	1,772	16	31,711	+ 5,093
Barnsley	176	231	143	164	163	161	153	162	16	2,443	17
Barrow	187	210	136	157	205	211	219	267	16	3,097	+ 586
Bath	511	843	606	674	574	613	576	603	16	8,875	+ 321
Belfast City	2,372	3,024	2,319	2,472	2,210	2,317	2,159	2,186	16	35,632	1,296
Birmingham, City of	5,205	6,148	5,228	5,451	5,740	5,748	5,710	5,651	16	86,508	+ 4,883
Birmingham and Midland	829	1,028	797	837	1,200	1,245	1,223	1,235	16	18,228	+ 4,782
Birmingham Corporation	...	319	269	268	369	362	368	335	3	1,170	+ 242
Blackburn Corporation	747	1,302	786	930	611	974	846	867	3	3,030	457
Blackpool and Fleetwood	498	631	266	313	270	243	221	536	16	3,546	438
Blackpool Corporation	337	1,444	532	556	414	412	420	462	3	1,295	1,166
Blackpool, St. Anne's, and Lytham	163	600	240	297	191	170	168	187	24	3,507	643
Bolton Corporation	2,041	1,810	1,810	1,794	1,862	1,820	1,826	2,354	4	6,706	+ 115
Bournemouth Corporation	829	1,383	1,148	1,165	992	679	991	994	3	2,665	- 1,032
Bradford Corporation	2,895	4,805	3,661	3,925	3,074	3,982	3,964	3,965	4	12,774	- 499
Brighton Corporation	923	979	881	844	849	810	879	992	4	2,949	98
Bristol	4,608	5,782	4,726	5,076	4,524	4,596	4,607	4,708	16	72,160	- 1,101
Burnley Corporation	1,223	971	945	1,035	1,099	1,127	1,038	1,367	16	16,460	+ 2,080
Burton-on-Trent Corporation	339	363	320	318	305	301	302	325	3	1,025	—
Calcutta	Rs. 32,902	32,172	33,208	33,353	38,794	40,374	39,009	35,743	15	604,563	+ 73,669
Cardiff Corporation	...	2,194	2,529	1,945	...	1,897	2,446	1,956	3	6,299	269
Carlisle, City of	194	231	180	197	151	177	182	188	16	2,413	388
Chatham and District	503	773	579	572	600	663	621	628	16	9,388	+ 984
Colchester Corporation	...	...	...	...	171	160	182	267	39	8,451	
Cork	398	462	434	442	418	462	432	448	16	6,575	+ 229
Darlington Corporation	...	...	...	...	179	182	185	192	3	560	
Derby Corporation	339	383	312	331	633	616	661	699	3	2,124	+ 965
Devonport	520	561	495	513	428	500	479	486	16	6,965	375
Dover Corporation	169	245	201	195	132	176	187	216	3	617	129
Dublin and Lucan	100	138	135	128	100	104	103	133	16	1,575	+ 2
Dublin United	4,181	4,936	4,578	4,916	4,377	4,617	4,620	4,594	16	70,674	+ 650
Dudley—Stourbridge	791	1,173	724	799	849	819	809	808	16	12,152	+ 131
Dundee City	767	861	892	832	795	826	865	764	44	39,935	- 299
East Ham U.D.C.	718	833	706	753	744	750	747	801	3	2,452	- 112
Edinburgh and District	4,191	4,363	4,280	4,657	4,425	4,625	4,501	4,516	16	71,134	+ 5,254
Gateshead	910	959	835	865	862	892	889	952	16	13,878	+ 340
Glasgow Corporation	13,411	14,045	13,996	14,935	14,682	15,184	15,064	14,716	47	670,563	+ 34,935
Glossop	109	101	96	105	126	112	121	127	16	1,770	+ 181
Gravesend and Northfleet	239	318	223	244	202	205	214	218	16	3,062	426
Greenock—Port Glasgow	478	459	565	539	615	592	696	572	16	8,606	+ 1,302
Harrow Road and Paddington	253	333	263	289	252	251	234	253	16	3,660	225
Hartlepool	275	319	246	258	253	237	232	249	16	3,831	— 93
Halifax Corporation	2 weeks	3,008	...	...	2 weeks	2,658	...	...	...	...	
Huddersfield Corporation	...	1,546	1,186	1,237	...	1,223	1,259	1,259	3	4,053	— 187
Hull Corporation	2,144	2,212	2,048	2,381	2,211	2,094	2,080	2,194	3	7,030	— 187
Ilford Corporation	...	403	414	...	...	544	426	...	...	...	
Ilkeston Corporation	186	119	...	189	116	107	...	153	...	...	
Ipswich Corporation	435	119	400	403	372	418	399	427	3	1,245	— 264
Kidderminster	103	182	97	113	96	101	98	98	16	1,469	— 122
Kirkcaldy Corporation	194	234	203	281	199	241	200	202	...	...	
Lanarkshire	570	605	562	766	608	653	630	646	1	10,079	+ 722
Leeds Corporation	5,318	6,185	5,125	5,532	5,471	5,476	5,442	5,414	3	21,802	— 137
Leicester Corporation	...	...	...	...	1,964	1,954	2,012	1,961	1	29,380	—
Liverpool Corporation	9,933	10,463	9,964	...	10,955	10,391	10,461	...	...	...	—
London County Council	8,876	11,770	10,465	...	10,817	13,405	13,590	...	...	...	—
London General Omnibus	21,268	23,943	24,213	25,578	...	23,000	...	21,139	1	329,454	+ 9,743
London Road Car	6,953	7,741	7,905	8,379	8,127	7,651	8,034	6,981	1	117,625	+ 2,408
Lowestoft	134	197	143	...	121	119	128	...	...	...	—
Maidstone Corporation	...	...	...	...	100	108	106	107	4	5,060	—
Manchester Corporation	11,563	12,127	11,367	11,700	11,923	11,982	12,146	12,640	3	36,768	+ 1,574
Merthyr	215	286	196	192	175	189	202	212	16	2,866	222
Metropolitan	1,264	1,526	1,246	1,348	2,290	2,171	2,020	2,890	1	31,558	+ 13,361
Middleton	303	403	266	325	285	308	294	342	1	4,353	+ 250
Nelson Corporation	...	107	103	116	112	123	119	153	1	443	+ 29
Newcastle-upon-Tyne Corporation	3,615	3,794	3,399	3,492	3,566	3,605	3,579	3,734	16	56,941	+ 1,114
Newport (Mon.) Corporation	488	561	448	464	541	522	584	569	3	1,676	+ 203
Northampton Corporation	144	195	161	146	369	371	376	386	3	1,134	+ 632
North Metropolitan	11,081	12,288	11,721	12,131	11,677	11,332	11,555	11,017	16	173,108	- 2,164
Oldham—Ashton	594	641	498	552	516	514	526	612	16	7,958	+ 37
Oldham Corporation	1,134	1,189	1,180	1,167	1,552	1,452	1,534	1,628	4	6,717	+ 1,513
Peterborough	143	190	127	144	123	110	114	133	15	1,690	182
Pontypridd U.D. Council	...	...	...	...	...	156	163	...	...	...	—
Poole	268	439	293	323	254	250	256	276	15	3,645	321
Portsmouth Corporation	1,706	2,468	1,678	...	1,626	1,606	1,685	...	...	...	-
Potteries	1,692	1,872	1,590	1,676	1,818	1,694	1,649	1,734	16	26,109	+ 477
Rossendale Valley	193	197	164	172	197	199	184	213	16	2,918	+ 280
Rotherham Corporation	422	619	392	458	461	422	391	387	3	1,159	690
Rothesay	57	166	93	117	54	59	81	119	16	841	94
Salford Corporation	4,377	3,771	3,952	3,881	4,050	3,865	3,986	4,803	4	14,579	+ 216
Scarborough	...	...	...	...	73	73	74	...	...	...	-
Sheerness	46	77	46	52	62	62	64	65	15	895	+ 156
Sheffield Corporation	4,371	4,886	4,392	4,554	4,682	4,681	4,548	4,623	4	18,918	720
Southampton Corporation	854	1,057	929	937	843	870	859	851	3	2,579	345
Southend-on-Sea Corporation	388	250	316	276	266	254	198	270	3	722	120
Southport	300	443	286	300	265	260	253	269	16	3,756	- 298
South Staffordshire	692	998	676	732	682	677	680	653	16	10,363	- 808
Stockport Corporation	573	567	420	530	487	488	467	640	3	1,596	- 89
Sunderland Corporation	...	1,091	1,118	1,170	...	1,138	1,071	1,183	3	3,725	333
Swansea	518	612	504	509	478	477	496	503	16	7,427	+ 25
Swindon Corporation	...	...	...	...	...	196	169	...	...	...	
Taunton	46	92	50	51	47	50	49	43	16	664	105
Tynemouth	256	335	224	250	188	197	177	198	16	2,795	637
Tyneside Tramways and Tramroads	296	421	281	335	353	384	339	337	16	5,313	+ 670
Wallasey U.D. Council	652	789	651	679	698	671	687	702	3	2,187	54
Walsall Corporation	...	579	426	463	464	457	458	449	16	7,131	241
Warrington Corporation	306	352	288	300	316	319	307	314	3	940	-
West Ham Corporation	263	807	691	754	1,167	1,187	1,093	1,177	3	3,458	+ 1,206
Weston-super-Mare	30	107	61	76	39	55	48	60	16	528	19
Wolverhampton Corporation	705	518	552	550	722	701	695	964	4	2,917	—
Wolverhampton District	348	539	326	367	362	355	352	345	16	5,467	+ 28
Worcester	255	376	247	270	276	279	283	288	16	4,132	+ 778
Wrexham and District	119	140	149	134	96	93	122	121	16	1,510	129
Yorkshire (Woollen) District	557	810	537	652	609	612	589	598	16	9,030	+ 627

(For Railway Companies' Traffic Returns, *vide* page 446.)

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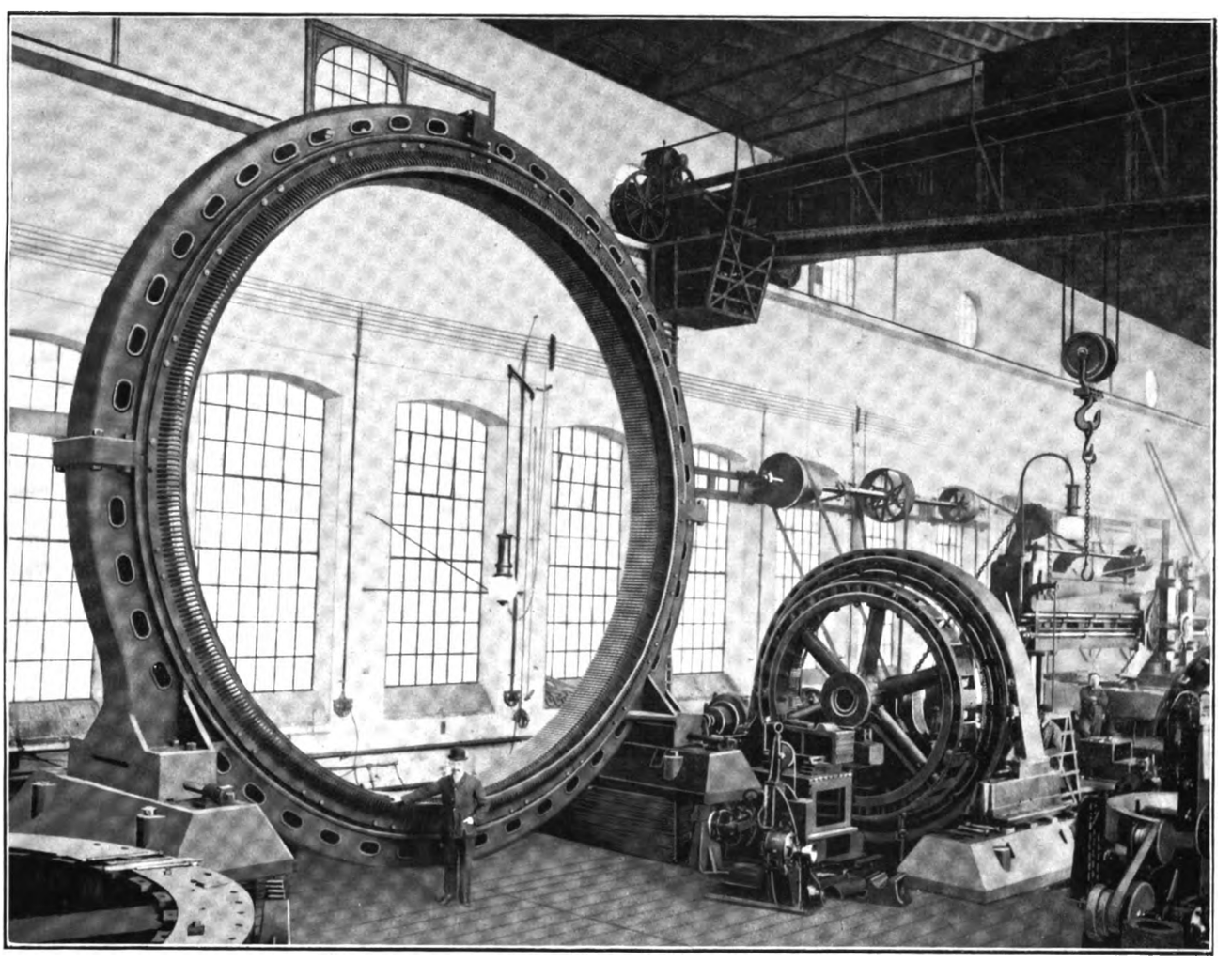
THE

ELECTRIC CONSTRUCTION CO., LTD.

Electrical Engineers and Contractors.



ARMATURE RING OF ONE OF **FOUR 3200 K.V.A.** THREE-PHASE ALTERNATORS UNDER CONSTRUCTION FOR THE LONDON COUNTY COUNCIL.

LONDON & WOLVERHAMPTON

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RAILWAY TRAFFIC RETURNS.

RAILWAY COMPANIES.	1904. WEEKS ENDING April 2.	April 9.	April 16.	April 21.	1905. WEEKS ENDING April 1.	April 8.	April 15.	April 22.	AGGREGATE. Wks.	1905	Increase or Dec.
	£	£	£	£	£	£	£	£		£	£
Brecon and Merthyr ...	1,863	1.691	1,782	1,768	1,692	1,705	1,798	1,717	16	30,498	+ 1,126
Cambrian	6.540	5,975	5,125	5,867	5,855	5,525	5.050	5,927	16	82,807	– 2,545
Central London	6.297	6.672	6,597	6,538	7,054	7,158	6.761	6,916	16	113,342	+ 2,003
City and South London ...	2.712	2,822	2,704	2,778	2,697	2,804	2,759	2,525	17	49,686	– 2,784
Furness	8,905	8.805	8,328	8,815	9.130	8.867	8,900	9,123	16	134.991	+ 2,886
Great Central	63.589	57,628	62.924	65.362	67,075	65.296	67,414	68,576	16	1,042,331	+ 59,193
Great Eastern	108,100	101.200	93,700	97.900	90.600	93,200	94.400	108,600	16	1,479,700	– 34,100
Great Northern	111,553	100,510	111.707	111,291	104.700	101,100	109,000	106,300	16	1,643,000	– 56,896
Great Western	235,200	217.000	231,600	232,400	208,400	215,400	230,200	248,000	16	3,372,800	– 9,300
Hull and Barnsley	7,350	7,403	8,643	9,668	8,144	8,199	9,120	8.343	16	136,982	+ 7,603
Isle of Wight	891	836	771	659	514	623	714	1,004	16	8,727	+ 31
Ditto Central	643	805	577	611	625	574	678	699	16	9,738	+ 162
Lancashire and Yorkshire ...	108,750	97.386	99.589	102,344	102,815	100,305	99,721	115,790	16	1,570,749	+ 35,707
Liverpool Overhead ...	1,547	1,776	1,629	1.618	1,489	1,499	1,533	1,475	16	25,092	– 1,268
London, Brighton, and South Coast	78,153	65,362	57,589	60,601	62.023	54,154	58.597	67,634	16	863,271	– 16 362
London and North-Western	275.000	246,000	273,000	272.000	273.000	258,000	270.000	273,000	16	4,047,000	– 46,000
London and South-Western	102.200	91,100	85.100	87.400	84,900	82.200	86,000	100,500	16	1,277,500	+ 10,100
London, Tilbury, and Southend	8,982	9,390	8,384	8,204	7,969	8,003	7 928	9,298	16	122,757	+ 763
Maryport and Carlisle ...	2,088	1,997	2,030	2,027	2,126	1,933	2,021	2,004	16	33,126	+ 1,346
Mersey	1,483	1,688	1,558	1,466	1,556	1,609	1,630	1.574	16	25.448	+ 1,469
Metropolitan	16.775	17,765	17,344	17,661	17,016	17.336	17.463	17,601	16	273,640	+ 1,365
Ditto District	6 960	7,181	7,234	7.495	7.439	7,197	7,165	6,508	16	120,198	– 3,436
Midland	231.913	197,753	218,255	215.319	205.458	210,868	218.972	222,776	16	3,364,378	+ 5,284
North-Eastern	192.085	171.602	139,226	166,851	169,783	170.095	165,349	183.137	16	2,593,281	- 14.146
North London	8,840	9,294	9,807	9 741	9,010	9,106	9.408	8,265	16	144,022	- 10,718
North Staffordshire... ...	18,956	18.018	15,555	17,790	16,789	17,413	16.401	18,561	16	270,378	– 7,982
South-Eastern and Chatham	103.483	96,420	84,357	86.917	79,131	93,531	84.620	98,473	16	1,264.429	- 18,115
Taff Vale and Penarth ...	16,991	15.424	19,212	19,419	20.054	19.034	19,045	17,190	16	293,710	– 3,242
Caledonian	87,599	84,195	84,487	83.498	85,123	80.643	84,677	86,910	12	960.423	+ 3,895
Glasgow and South-Western	35.877	33.768	32.087	32.403	32,513	30,790	31,936	33,580	12	368,644	– 6,367
Glasgow District Subway ...	1,398	1,395	1,364	1,325	1,377	1,383	1,344	1,342	12	16,089	– 190
Great North of Scotland ...	9.305	9.395	9,144	9.084	8.722	9.028	8,703	8,708	12	99,287	– 3,016
Highland	9.219	8.940	8,829	8.401	8,592	8,620	8,714	8,106	12	99,619	– 3,760
North British	88,388	87.309	89,669	88,040	83.835	84.608	89,991	90,743	12	1,008,940	+ 1,839
Belfast and County Down ...	2,675	3,152	2,480	2,475	2,379	2.400	2,472	2,789	16	37,449	– 1,175
Cork and Bandon	1,486	1,507	1,640	1,666	1,392	1,702	1,702	1,704	...	...	
Dublin, Wicklow, and Wexford	5.798	5,158	4,298	4,802	5.750	4,586	4,612	4,813	16	74,675	+ 2,311
Great Northern of Ireland ...	18,030	19,221	18,939	18.001	17,055	16,785	18.848	18,344	16	261.238	– 5,541
Great Southern and Western	23,462	26.659	25.454	26,890	25,452	25,778	25,600	23,546	16	358,711	– 10,591
Midland Great Western ...	12,503	9,806	11.824	11.929	12,649	10,017	11.274	10,253	...	161,273	– 5,841
Great Northern and City ...	983	990	908	915	1,618	1,619	1,538	1,473	16	25,493	-

THE WINBY "ANCHOR" CHAIRS & RAIL JOINTS.

Many thousands of Winby Anchor chairs are in use on the best Tramway Systems, their many advantages having been fully recognised. They are manufactured wholly from Rolled Steel Joist, and form a transverse girder of unquestionable strength and rigidity. Owing to their simplicity and fewness of parts, Winby chairs are inexpensive, while the simple and convenient manner in which they are fixed goes far to account for their popularity. As a Joint Anchor for tramways they are unrivalled; many thousands have also been adopted as intermediate anchors, preventing the creeping or displacement of tramrails from their original position. Wherever used, results have been entirely satisfactory, and a considerable saving in maintenance expenses has been effected.

For **Tramway Repair Work** the Winby anchor chairs are most advantageous, the use of bolts or rivets being dispensed with. Tramrails may be brought back to alignment and firmly secured in their correct position with very little labour or expense with the use of Winby chairs. They also form an inexpensive method of restoring low Joints to surface.

SOLE MANUFACTURERS and PATENTEES:

L. P. WINBY & CO.,

20, KING WILLIAM STREET, LONDON, E.C.

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THE Tramway & Railway World
A REVIEW OF CURRENT PROGRESS IN ELECTRIC AND OTHER TRACTION

VOL. XVII. LONDON, JUNE 8, 1905. VOL. XVII.

BAKER STREET AND WATERLOO RAILWAY.

The work of constructing and equipping the Baker Street and Waterloo Railway is now far advanced, and it is expected that the greater part of the line will be open for traffic by the end of the present year. The railway is the first to be completed of the group of London tube lines associated with the Underground Electric Railways Company, of London. Unlike the Great Northern, Piccadilly, and Brompton Railway and the Charing Cross, Euston, and Hampstead Railway, however, a great deal of tunnel work had been done before the undertaking passed into its present hands, and the construction was well advanced before ground had been broken for the other two lines mentioned.

In previous articles we have sketched the general relations between these three tube railways and the Metropolitan District Railway.* The Act of Parliament incorporating the Baker Street and Waterloo Railway Company and authorising the construction of an underground electric railway in London between the two points mentioned was passed in 1893, but the work of construction did not start till some time afterwards. There were various difficulties which need not be

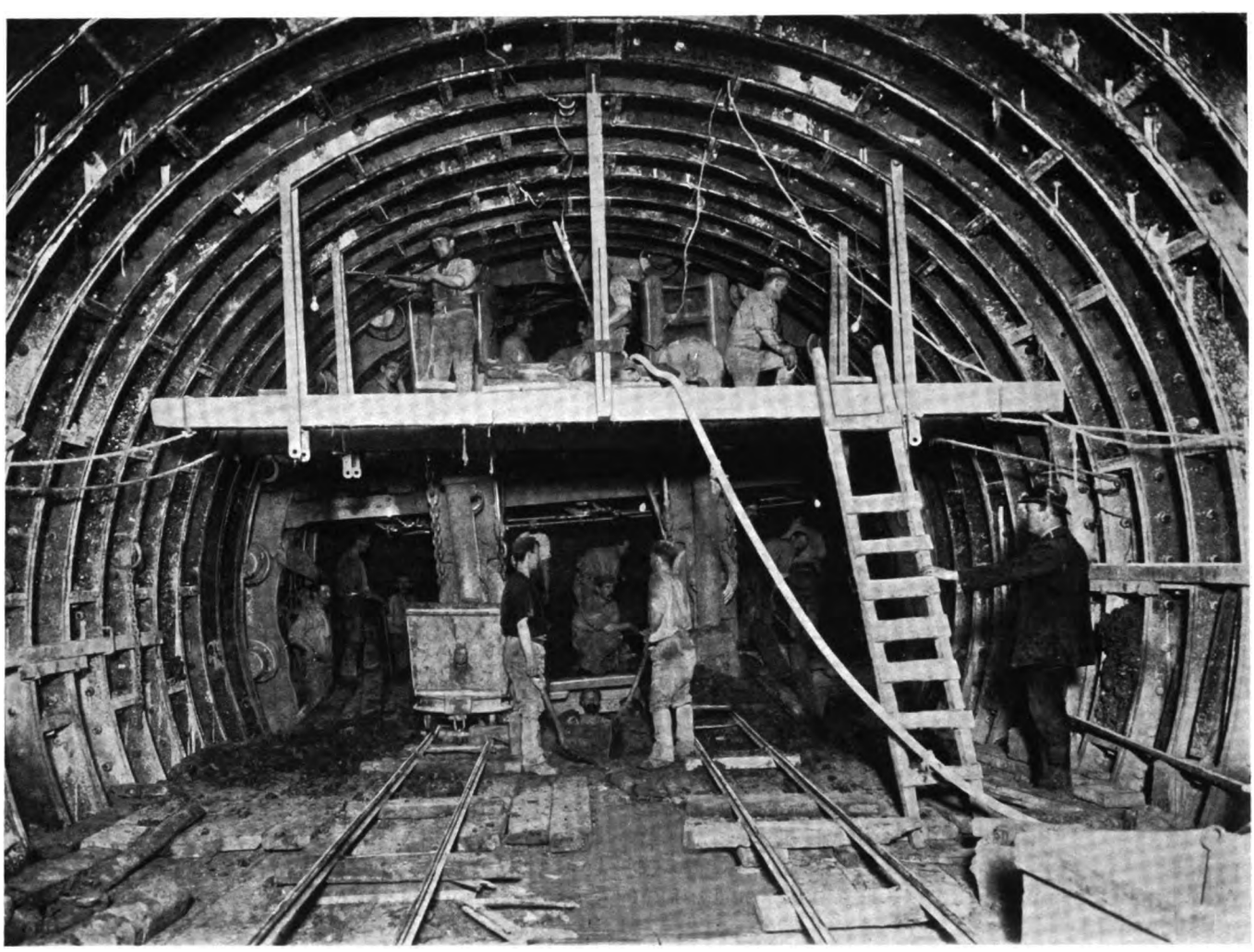

Fig. 1.—Driving the Greathead Shield at Edgware Road Station Tunnel, April 13, 1905.

* *Vide* THE TRAMWAY AND RAILWAY WORLD, January 15, 1903, and February 9, 1905.

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recalled, but ultimately Mr. C. T. Yerkes acquired a controlling interest, and arrangements similar to those made for the other two tube lines were entered into, whereby the work of construction was pushed forward energetically.

FINANCIAL.

The authorised capital of the Baker Street and Waterloo Railway Company is £2,673,000 in shares, and £890,000 in four per cent. perpetual debenture stock, a total of £3,563,000. The amount of share capital at present created is £660,000 in four per cent. £10 preference shares, and £1,725,000 in £10 ordinary shares — total, £2,385,000. Out of this there have been issued and fully paid the whole of the preference shares and £981,850 of the ordinary shares—total £1,641,850. Of the debenture stock, £500,000 was sold to the public early this year by Messrs. Speyer Brothers, who acquired it from the Underground Electric Railways Company, who, in turn, had received it in part payment for carrying out the construction and equipment of the railway.

Under the arrangement between the Baker Street and Waterloo Company and the Underground Electric Railways Company, contracts were entered into under which the latter Company will hand over the line to the former in sections, fully equipped and ready for traffic, to the satisfaction of the Board of Trade, and maintain each section for twelve months after its opening for public traffic, and will pay to the Baker Street and Waterloo Company £50,000 for working capital, in consideration of £2,575,542 payable as to £1,527,610 in shares, as to £857,000 in debenture stock, and as to the balance in cash and securities.

THE ROUTE AND THE TRAFFIC PROSPECTS.

The total length of the railway when completed will be five and a quarter miles, but out of this about half a mile, from the west of Edgware Road to Paddington, is not yet under construction. The opening and working of the line will, however, not be delayed on account of this piece. It forms the north-western part of the extensions which were comparatively recently authorised. The general route of the railway and its disposition with respect to other lines may be gathered from the map given on page 99 of our issue of February 9 last in connection with the article on the District Railway, while the diagram on a larger scale (Fig. 2) shows the form of the route.* The southern end is at the Elephant and Castle, where the terminal station is in close proximity to the Elephant and Castle stations of the City and South London Railway and of the Chatham and Dover Railway, while the London County Council electric tramways radiate from this spot in all directions. The point is thus a very advantageous one, both for the public and for the railway company. There are in all twelve stations on the railway which, taken from south-east to north-west, are:

Elephant and Castle.	Oxford Circus.
Westminster Bridge Road.	Regent's Park.
Waterloo.	Baker Street.
Embankment.	Lisson Grove.
Trafalgar Square.	Edgware Road.
Piccadilly Circus.	Paddington.

At Waterloo, passengers will change to and from the London and South Western, the Waterloo and City, and the South Eastern Railways. At the Embankment Station they can transfer to or from the Charing Cross Station of the District Railway. Following the principle of keeping under roadways, the line runs from Trafalgar Square (where passengers can change to the South Eastern and, when completed, to the Charing Cross and Hampstead Railway) under Cockspur Street and Haymarket to Piccadilly Circus, where there are subways for passengers connecting with the Great Northern, Piccadilly, and Brompton Railway. Passing up Regent Street, another interchange can be made at Oxford Circus with the Central London Railway. The line then runs under Portland Place and the edge of Regent Park. At Baker Street passengers may change to or from the Metropolitan Railway, while at Lisson Grove there is a subway close under the street surface communicating with the Marylebone terminus of the Great Central Railway. When the extension to Paddington is completed, a similar change will be

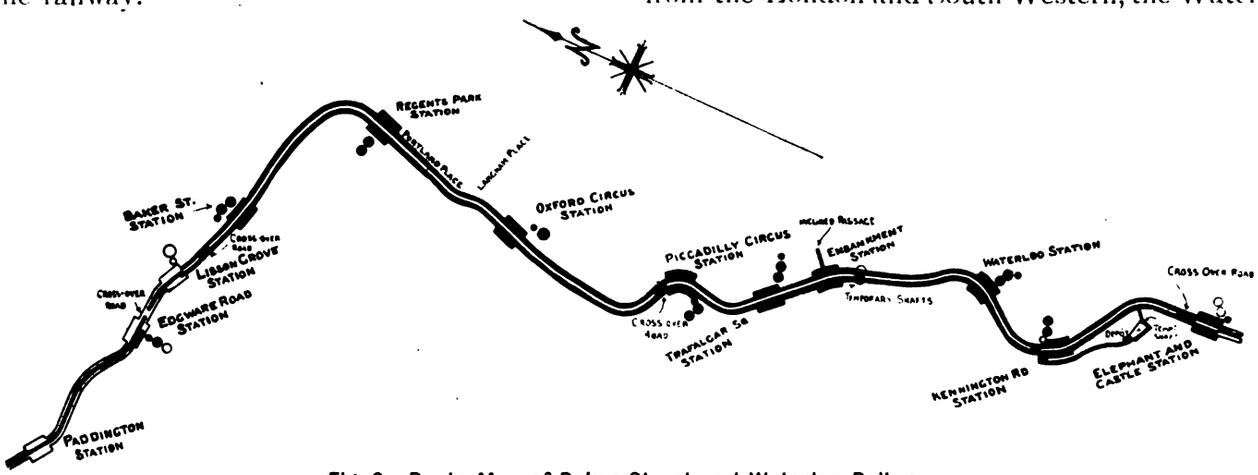

Fig. 2.—Route Map of Baker Street and Waterloo Railway.

* The map referred to was given in our issue for February 9, which is now out of print; it is reproduced as a supplement with this issue.

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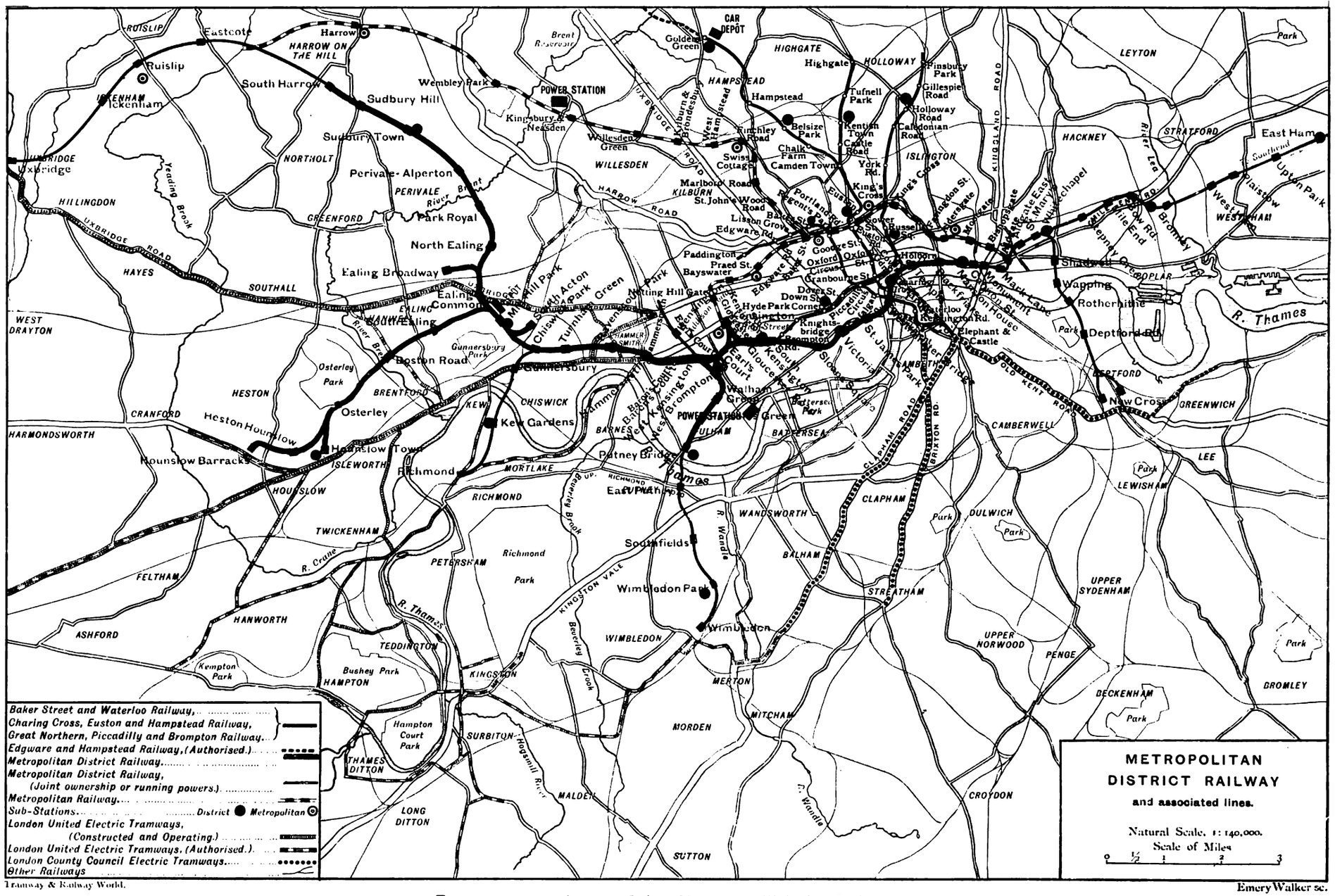
METROPOLITAN DISTRICT RAILWAY
and associated lines.
Natural Scale, 1: 140,000.
Scale of Miles
0 ½ 1 2 3
Baker Street and Waterloo Railway,
Charing Cross, Euston and Hampstead Railway,
Great Northern, Piccadilly and Brompton Railway.
Edgware and Hampstead Railway, (Authorised.)
Metropolitan District Railway.
Metropolitan District Railway,
(Joint ownership or running powers.)
Metropolitan Railway.
Sub-Stations. District Metropolitan
London United Electric Tramways,
(Constructed and Operating.)
London United Electric Tramways. (Authorised.)
London County Council Electric Tramways.
Other Railways
POWER STATION
CAR DEPOT
Harrow
Eastcote
Ruislip
Ickenham
South Harrow
Sudbury Hill
Sudbury Town
Perivale-Alperton
Park Royal
North Ealing
Ealing Broadway
Ealing Common
Boston Road
Gunnersbury
Kew Gardens
Osterley
Heston Hounslow
Hounslow Barracks
Hounslow Town
Richmond
Putney Bridge
Southfields
Wimbledon Park
Wimbledon
Earls Court
Walham Green
Hammersmith
Kensington
Knightsbridge
Victoria
St. James's Park
Charing Cross
Mansion House
Monument
Mark Lane
Aldgate East
Whitechapel
Bow Rd.
Mile End
Stepney Gr.
Bromley
Shadwell
Wapping
Rotherhithe
Deptford Rd.
New Cross
Elephant & Castle
Kennington Rd.
Brompton
Hyde Park Corner
Piccadilly Circus
Oxford Circus
Tottenham Ct. Rd.
Euston
Kings Cross
Holborn
Bishopsgate
Liverpool St.
Moorgate
Finsbury Park
Highgate
Hampstead
Golders Green
Brent Reservoir
Wembley Park
Kingsbury & Neasden
Willesden Green
Kilburn & Brondesbury
West Hampstead
Finchley Road
Swiss Cottage
Belsize Park
Chalk Farm
Camden Town
Kentish Town
Tufnell Park
Holloway Road
Caledonian Road
Gillespie Road
Marylebone
Paddington
Praed St.
Bayswater
Notting Hill Gate
Edgware Rd.
Lisson Grove
Marlborough Road
St. John's Wood Road
Portland Rd.
Regents Park
Baker St.
Gloucester Rd.
Kensington
Chiswick Park
Acton Town
Turnham Green
Ealing Broadway
Uxbridge
Rickmansworth
Watford
Aldgate
Bishopsgate
Moorgate
Liverpool St.
Stepney Gr.
Mile End
Bow Rd

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possible to or from the Great Western Railway terminus.

It will thus be seen that the railway will serve many of the most important districts in London, running as it does through the heart of the West End shopping centre, and the region of clubs, hotels, and theatres, while at its southern end it is in the centre of a great working class population. This fact, together with the numerous interchange facilities with other railways, points to a very heavy traffic. In February last Mr. Stephen Sellon, M.Inst.C.E., prepared a report for the company, in which he estimated that the line will carry 35,000,000 passengers per annum. Mr. Theodore J. Hare, chairman of the company, in transmitting this report to Messrs. Speyer Brothers, in connection with their issue to the public of debenture stock, said in a letter published with the prospectus that, assuming the average receipt per passenger to be 1·86d. (about the same as on the Central London Railway), and the miscellaneous receipts to amount to £10,500 per annum, the total gross revenue would amount to £281,750. Mr. James R. Chapman, engineer-in-chief of the Underground Electric Railways Company, had estimated that the total working expenses would amount to £135,281 per annum. This left a net revenue of £146,469. Interest on £890,000, the total borrowing powers of the company, would amount to £35,600 per annum, leaving a surplus net revenue of £110,869.

Some of the passages in Mr. Sellon's report, which are of wide interest, are here summarised. With the average speed of 14 miles per hour, which the equipment is calculated to maintain, it will be possible to travel from the Elephant and Castle to Paddington in 22 minutes, from Waterloo to Paddington in 17 minutes, from Charing Cross to Paddington in 14 minutes, from Marylebone to Waterloo in 13 minutes, and from Marylebone to Charing Cross in 10 minutes. The extent to which existing means of transport are used is a measure of the tendency to travel along any particular route and an indication of the extent to which new means offering advantages over those existing will be utilised. The only public transit service at present covering the whole route of railway is afforded by omnibuses. These carry about 183,000 passengers per week-day. . Comparing this with similar figures over the route of the Central London Railway, Mr. Sellon finds that before that line was opened the 'bus passengers averaged about 158,000 daily. On this basis the prospects are superior to the results realised on the Central London Railway. In reference to the prospects of traffic owing to the line having stations adjoining the termini of several trunk railways, the total number of passengers leaving and arriving at these termini is 100,000,000 per annum. A very moderate estimate of the number of passengers carried on the South London tramways, who wish to get to or from the districts served by the Baker Street and Waterloo line, is 20,000,000 per annum. Taking these and all other considerations into account, Mr. Sellon arrives at his conclusion that the railway may be confidently expected to carry 35,000,000 passengers annually. The three-minute service arranged for is ample to carry more than the number of passengers mentioned.

GENERAL ARRANGEMENTS.

Speaking generally the railway is on a gradually ascending gradient all the way from the Thames to Paddington. The inclines, however, are not severe, but curves are numerous and the radius of the sharpest is 5 chains or 330 ft.

Before describing the work of tunnel construction, the general arrangement may be indicated. As in other railways of the class, each track is in a separate circular tunnel which is lined throughout with cast iron segments bolted together. The whole of the tunnels, with a small but important exception, are in the London clay which is such a suitable material for excavating. There are three internal diameters of the running tunnels, 11 ft. 8¼ in. on straight track and on curves of not less than 20 chains radius, 12 ft. on curves of not less than 10 chains radius, and 12 ft. 6 in. for sharper curves. At the passenger stations each tunnel is of 21 ft. 2½ in. diameter. The permanent way is of exceptional weight and strength and presents several new features. Lifts are installed at all the stations, as well as powerful ventilating fans so as to preserve a pure atmosphere in the tunnels. The whole railway from end to end, including the stations, may be regarded as fire-proof. Neither pains nor money has been spared to secure this end. The cars are built entirely of non-combustible materials, steel being the chief element. The electric working will be on the multiple-unit control system, three sub-stations being employed which receive the energy from the great Chelsea power-station of the Underground Electric Railways Company of London.*

TUNNEL CONSTRUCTION.

The contract for the construction of the tunnels and the laying of the permanent way of the original portion of the railway from Baker Street to Waterloo was let to Messrs. Perry and Company, Tredegar Works, Bow, and they also have the contract for the extension from Baker Street to Edgware Road. The work of the extension from Waterloo to the Elephant and Castle, together with the formation of the depôt at St. George's Circus, is in the hands of Messrs. John Mowlem and Company, Millbank.

The first thing to be done was to erect a large staging in the river Thames, close to Hungerford railway bridge. From this a shaft was sunk through the bed of the river to the depth of the railway, and this shaft has ever since been in active employment for the removal of excavated material, and for taking in the iron segments and

* This station was fully described and illustrated in the article on the Metropolitan District Railway in our issue of February 9 last.

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everything else required for the construction of the tunnels and tracks. The materials were conveyed in barges. The clay excavated from nearly the whole original section of the railway was removed in this way. Temporary narrow gauge tracks were laid in the tunnels, and the hutches were hauled on these by a little electric locomotive taking its power from an overhead wire. Electricity was generated by a small plant erected on the staging in the river, and this plant was also used for lighting the tunnels and works.

The shaft having being sunk in the river bed to the required depth, chambers were formed in which the usual Greathead cutting shields were built, two being used for each tunnel, one driving north and the other south. In crossing under the river exceptional difficulties were encountered from water. The line for a considerable distance is not in the clay at all, but in loose gravel full of water from the river above, so that the driving had to be done under compressed air. When the Waterloo and City Railway tunnels were made under the Thames similar difficulties were encountered. We propose here to describe how the work was carried out on the Baker Street and Waterloo line, the method being based on that employed in the case of the other railway, and we shall deal first with the ordinary work in the clay and afterwards with that in the water-bearing strata.

The Greathead shield (Fig. 1), as is well-known, consists of a relatively short steel plate cylinder of the diameter of the tunnel to be excavated, with a cutting edge at the front end which forms part of a strong ring casting on the face of the shield. Behind the cutting edge seven or eight hydraulic rams, each 7 in. in diameter, are ranged round the circumference of the shield, being held in place by a cylindrical casting. Hydraulic pressure is obtained by means of an air pump fixed on the shield and driven by compressed air, the hydraulic pressure being about 1,200 lb. to 1,600 lb. per square inch. From this pump the water pipes are led to the rams, and the hydraulic pressure is readily applied. For a short distance there is a flexible pipe for the compressed air possessing some slack, so that the shield may move forward and, when necessary, fresh lengths of iron-pipe are added. The rams take their purchase off the projecting flange of the last ring of cast-iron lining segments which have been erected, and a thrust of 20 in. at a time is made.

In front of the shield for a distance of eight feet or so a heading some 6 ft. wide and high is driven into the clay by the labourers, or miners as they may really be called. This heading represents about 30 per cent. of the whole working face. The shield is then forced forward. The cutting edge provides for the tunnel circumference, while piles attached to the front of the shield pierce the remainder of the working face and break it down. The material is shovelled into hutches on the temporary tracks and hauled away, while empty hutches are as rapidly brought forward. A new ring of iron segments is built up inside the rear end of the shield, so that the tunnel walls are never left unsupported. The length of each ring is 20 in., and thus each stroke of the rams provides just the space for an additional ring. When the shield goes forward it of course leaves a narrow annular space between the iron and the clay walls, and this is immediately filled with a grout of blue lias lime and water which rapidly sets. A small air compressor provides a driving force of about 60 lb. on the square inch, and by this means the grout is forced through flexible pipes which are passed through holes made for the purpose at various points in the circumference of each ring. The entire annular space is thus filled with the grout. In the running tunnels the segments of the rings were erected by hand, and bolted by their flanges to the preceding rings. A short key segment at the top was put in last. The rate of progress was about 44 rings, meaning a distance of 73 ft. 4 in., per week. The longitudinal joints of the rings are machined so as to secure the circularity of the tunnel, this being an improvement on the unmachined faces used on some previous tube railways. The joints between separate rings have wood packing of various thicknesses inserted, and in this way any slight irregularity in erection of segments can be compensated by varying the thickness of the wood.

In the station tunnels the shields, of course, had to be much larger, and the work of excavating the preliminary chamber and building the shield was of much greater magnitude. At some stations work was begun independently, the running tunnels not having reached the spot, but in most cases the running tunnels were first carried on to the station site. The practice then was to drive a gallery upwards from the face of the running tunnel to the height required for the top of the station tunnel, and at the top drive a heading for a distance of about 18 ft. The roof of the heading is supported by steel joists placed longitudinally, and these are held up at each end by strong timbers resting on foot blocks. The heading is then gradually enlarged both laterally and vertically, and fresh supports for the roof are added as required. When this excavation has been completed, eight station tunnel iron rings are erected in the chamber under cover of the steel joists, the space between the top of the rings and the joists being filled in solid with concrete. The shield is then erected inside the rings, and the hydraulic connections being made it can begin to work. Each of these large shields has 22 rams. The working face is divided into nine compartments, and small hydraulic erectors are used for lifting the iron segments which are, of course, larger than those used in the running tunnels, while those for the upper part of the tube have to be lifted much higher. The erecters are mounted on the framing of the

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shield. No central heading is driven by hand, the whole face being attacked by piles on the shield. A capital view of the work in progress at Edgware Road station is shown in Fig. 1., while Fig. 3 is a cross section of a station with the relative size and position of the running tunnel indicated.

It was, of course, of the utmost importance that the direction of movement of the shield should be constantly checked both laterally and vertically, so that there might be no unwitting deviation. To prevent lateral deviation, each shield had two graduated scales attached to it, one on each side, and below each scale a piece of wood was fixed on the side of the tunnel. On these pieces of wood marks were made so that, in the case of straight tunnel, a line joining the two marks on the two pieces of wood was truly at right angles to the longitudinal axis of the tunnel. So long as the shield moved accurately forward, the scales in relation to the marks on the pieces of wood read the same amount on either side. On curves, one of the scales was put on the shield on the outer side of the curve, while on the inner side a "shrunk" scale was fixed, the shrinkage corresponding to the difference in radius of the curves formed by the two sides of the tunnel wall. With regard to preventing vertical deviation, two inverted T squares were suspended from the crown of the tunnel at some distance apart. A mark corresponding to the level of the horizontal bar of the squares was made on the shield, and by sighting from the more remote T it could be seen where the shield was lying above or below the proper level. If the shield was found on any occasion out of line, it was corrected on the next thrust by shutting out of action the rams on the side too far forward.

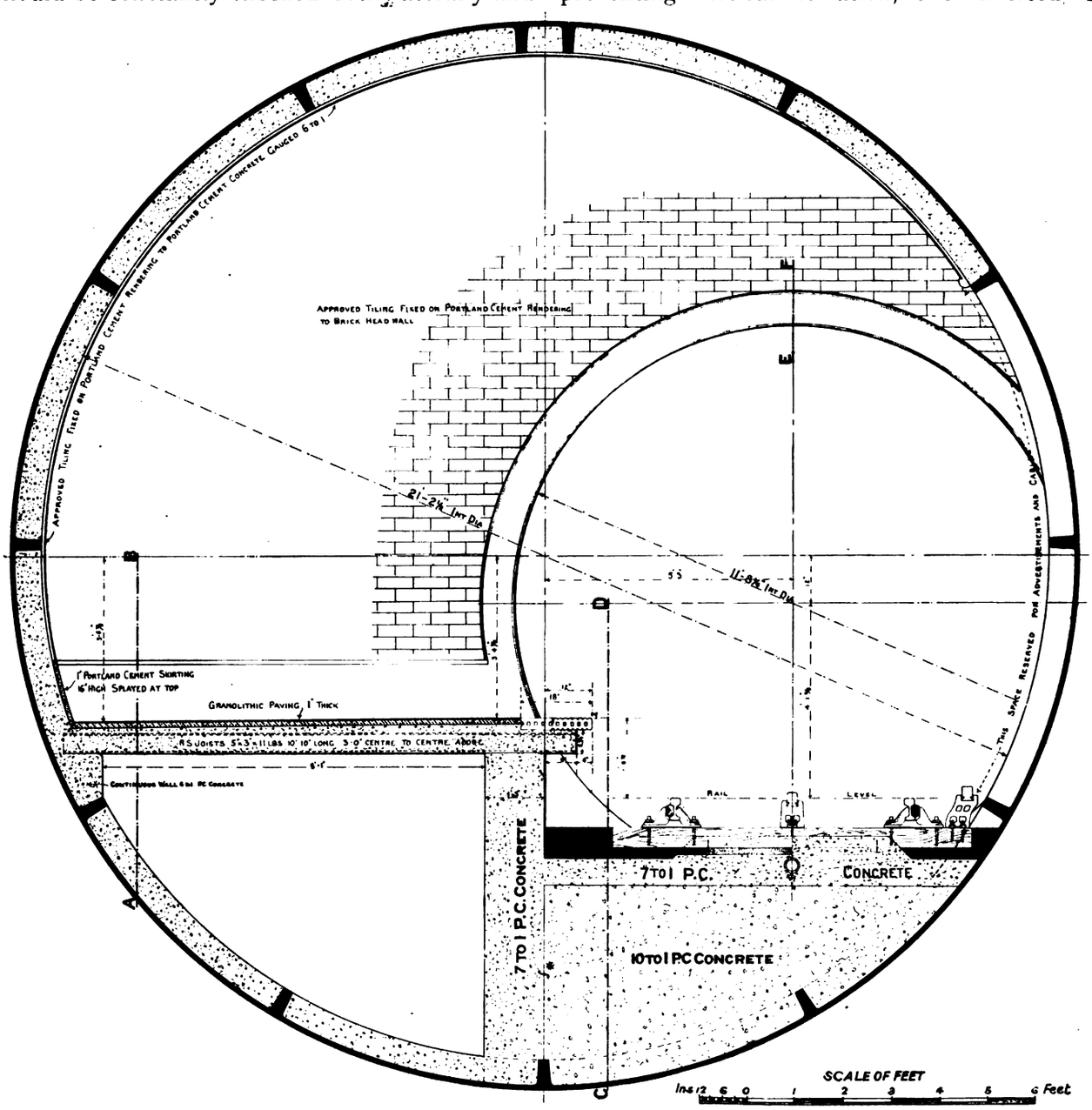

Fig. 3.—Section of Station and Running Tunnels, Platform, and Track.

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In driving the tunnels under the Thames through water-bearing gravel a special form of shield together with compressed air had to be employed. Not only had the water to be kept out, but the gravel had to be supported during the work of excavation. Fig. 4 is a section of the river and the strata below, and of one of the tunnels, showing relative positions. The depth of the gravel had been ascertained by trial borings, so that all the arrangements were made before the tunnel work was begun. Air-locks, being chambers built of steel plates with doors in each end, were built in the tunnels some distance back from the beginning of the water-bearing strata. These were worked in the usual way. Men entering the lock closed the air-tight door behind them, opened the valve in the front of the lock, and as soon as the air pressure from the tunnel in front had become equalised in the lock the valve was closed and the inner door into the workings opened. On coming out the reverse process was gone through, a valve in the outer end of the lock reducing the pressure inside it to that of the atmosphere.

The gravel working face was boarded up with timber, so as to allow the air to be compressed without abnormal waste. The method of procedure was somewhat as follows. A small hole was driven into the gravel at top of the face. This produced a great rush of air into the river so that an action like boiling was visible on the surface. The hole was at once filled with clay brought from other parts of the workings. As the clay had been made soft in a pug mill, it at once made the hole air-tight. A succession of other holes abutting on one another were then made round the circumference of the working face and filled with clay. Each hole was about 12 in. square by 22 in. long, giving about a couple of inches to spare beyond the 20-in. thrust of the shield. The holes were also made in such positions that when the shield was afterwards moved forward, there was a layer of clay outside the skin of the shield. In this way an annular ring of clay was formed, with a break, however, at the bottom of the invert. The shield was provided with a protecting hood which at the bottom projected some two feet in front of the cutting edge. The shield was driven forward, the cutting edge going quite easily through the soft clay. The gravel face was then dug out for about 20 in., the boarding erected again on the new face which was previously smeared with clay so as to make it air-tight, a new ring of segments was erected and the process already described repeated again. By this means the miners had always the protection of the shield over their heads when at work. The air pressure combined with the skin of clay over the newly-exposed surface prevented any inrush of water, and the grouting was carried out in the usual way. In the tunnels under the river, a sump has been constructed to catch any water which may get in. The water is taken away by an electrically driven pump.

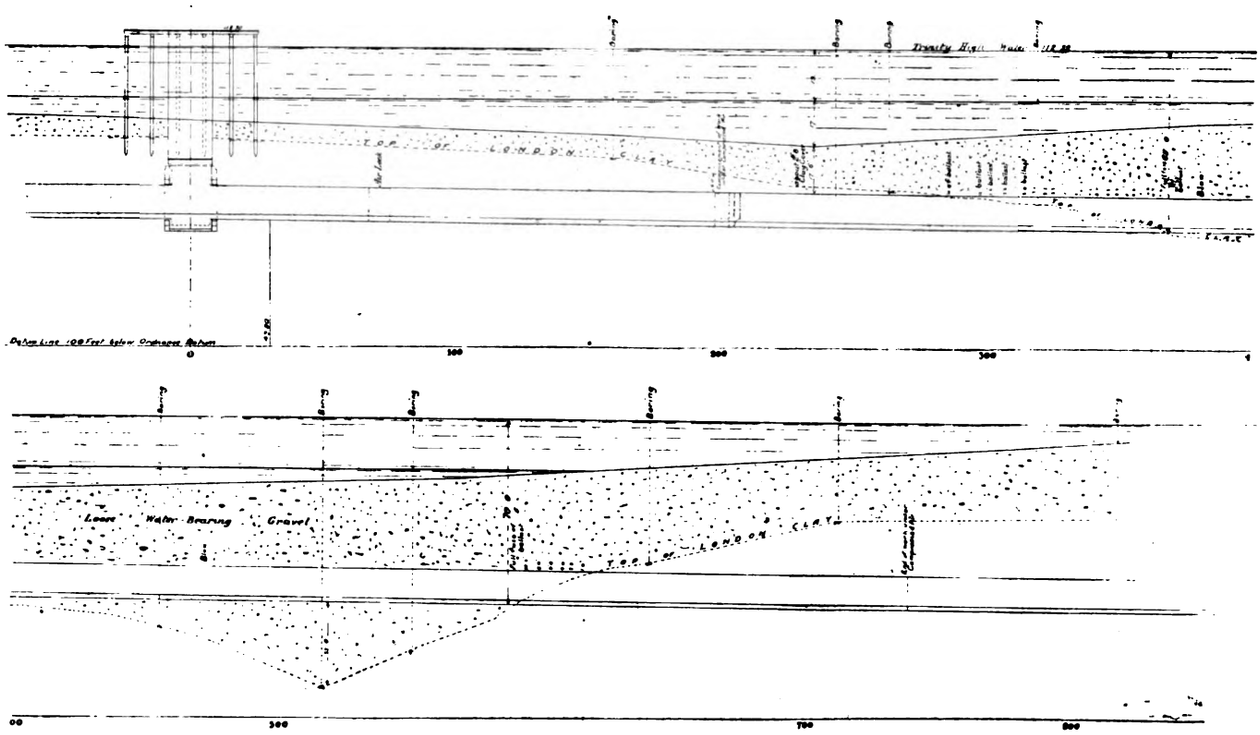

Fig. 4.—Section through River, Sub-Strata, and Tunnel.

When the junction of the tunnels near Waterloo Station constructed by Messrs. Perry and Messrs. Mowlem was affected, it was found that the alignment was practically absolutely accurate.

It may be of interest to note that at the Elephant and Castle terminus the bottoms of the tunnels are below the London clay, and penetrate slightly into the green-sand, otherwise known as the Woolwich and Reading beds.

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This is not because the tunnels are deeper there than elsewhere but because the London clay is not so thick.

The Baker Street and Waterloo Railway Company's engineers for the work are Messrs. Baker, Galbraith, and Church, and the carrying out of the tunnelling was supervised for the Underground Electric Railways Company by their tunnel engineer, Mr. H. H. Dalrymple Hay.

PERMANENT WAY.

The permanent way is of standard gauge and the laying of it has been carried out by the contractors for the tunnel construction under the superintendence of Mr. W. E. Hanson, for the Underground Electric Railways Company. The track arrangement may be gathered from the section drawing (Fig. 5) which shows the tunnel invert, the concrete foundation of the sleepers, the track rails, and the conductor rails. The whole construction is of an exceptionally strong and solid character, while, at the same time, provision has been made for a certain amount of elasticity of track, so as to minimise noise and vibration. It will be seen that the bottom of the invert is filled with a bed of concrete with sloping sides. The concrete was not quite so high when laid as the bases of the sleepers were intended to be. The sleepers were laid upon it, and then wedged up to their proper level. Fine concrete was next run under the sleepers to fill the space, and between the sleepers the spaces were filled up with concrete to a level with the top of the wood. A cross iron lip is bolted below each sleeper, and this lip is sunk in the concrete so as to prevent the sleeper from moving endways. An angle iron is placed at each edge of the bench of concrete to prevent the grout from running out. A longitudinal drain runs centrally along the surface of the concrete, and cross drains about 10 yards apart bring any water from the sides of the track into it. The ends of the sleepers overhang the edges of the concrete bench and are bedded in crushed granite. As the track rails are above the overhang, it is expected that a little elasticity will be obtained in this way.

The sleepers are of Karri wood, and are of great solidity and weight in comparison with the ordinary railway sleeper. Since the time of the fire in the tunnel of the Liverpool Overhead Railway, the Board of Trade will not allow creosoted sleepers to be laid in railway tunnels, and it is believed that ordinary uncreosoted wooden sleepers would only last for a very few years. The Karri wood sleepers are expensive, having to be imported from Australia, but it is believed that they will be cheap in the long run. They are practically fire-proof, and may almost be described as everlasting. They are sawn square, and their lower sides taper upwards at the ends so as to conform with the slope of the tunnel tube. They are spaced very near to one another, though sometimes at varying distances, as their ends have to come between the flanges of the segments of the tube, and slight variations have to be made at the rail joints. The sleepers are in two sizes, the larger size being for those which carry the insulators for the conductor rails, and the ordinary sleepers. The ordinary sleepers are 6 ft. 6 in. long, 14 in. wide, and 5 in. thick. Those for the insulators are of the same width and thickness, but are 7 ft. 7 in. long.

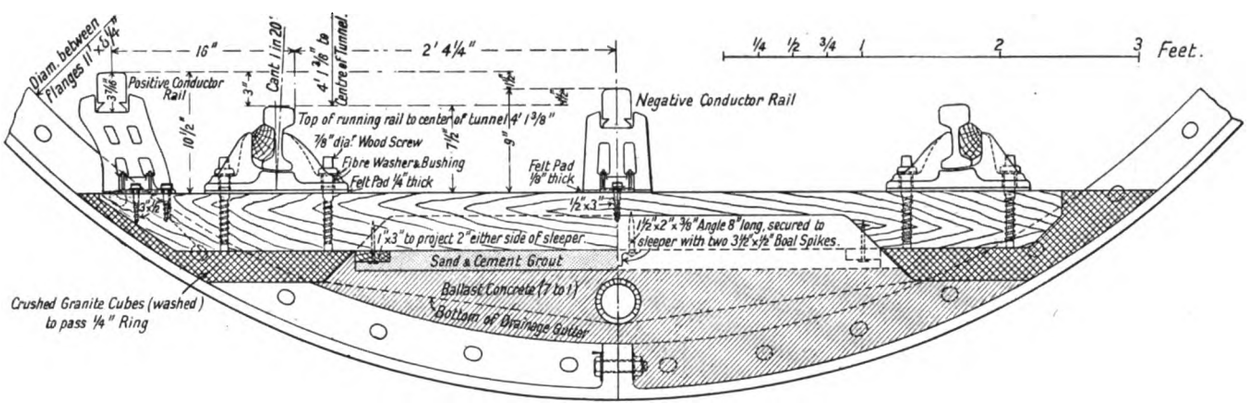

Fig. 5.—Section through Lower Segment of Tunnel showing Arrangement of Track.

The joint sleepers are 10 in. by 5 in. by 6 ft. 6 in. The sleepers, like all the other material for the permanent way, were landed at Purfleet, brought up the river in barges, and lowered down the shaft in the Thames near Charing Cross.

The running rails are the standard 90 lb. bull-headed British railway rail, and were supplied by Messrs. Bolckow, Vaughan and Company in lengths varying from 34 ft. 11 in. to 36 ft. 5 in. The varying lengths were required to keep the joints opposite one another on curves. On the other tube railways which are now under construction by the Underground Electric Railways Company, the rail lengths measure 45 ft. but this length could not be used on the Baker Street and Waterloo line, as a rail of that length could not be got down the shaft in the river. That trouble has been obviated latterly by the opening to the surface, which has now been carried out at the depôt at St. George's Circus. The rails for the curves were bent after being taken down into the tunnels. The chairs upon which the rails rest are held down to the sleepers by screw bolts instead of driving bolts (Fig. 6). A fibre

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insulator is put round the neck of the bolt where it goes through the chair, so as to prevent the wandering of any leakage currents. Under each chair is placed a felt pad a quarter of an inch thick. This is made of the shape of the base of the chair, and is intended to deaden the noise of the train. A special chair, similar to that employed for the same purpose on the Great Western Railway, is used at the joints (Fig. 6). The track laying was only begun in September last, and so far

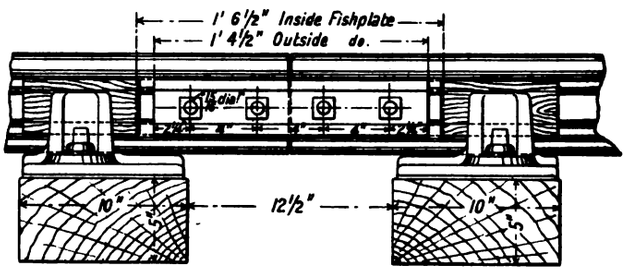

Fig. 6.—Joint in Running Rails.

as the original section of the railway is concerned, it is now complete. The work involved a good deal of trouble, as the contractor's temporary way had to be taken up and a lot of accumulated dirt in the bottom of the tube cleared away. Seven gangs of men were employed simultaneously at different places.

The conductor rails, which were supplied by The Aachener Hütten Actien Verein, are of a totally different pattern from any employed hitherto. Instead of an inverted channel or a flat-bottomed bull-headed rail, this section is practically a solid square. It may be seen in the drawing, Fig. 5. The object was to save space vertically, an important matter in a tube railway, and at the same time to get the high electrical conducting power of the big rails employed on the District Railway. This section is considerably lower than the one just referred to, though it is also somewhat lighter, weighing 85 lb. per yard, against 100 lb. in the case of the District Railway. The chemical composition is as follows:

Carbon	·05 per cent.
Manganese	·19 ,,
Sulphur	·05 ,,
Phosphorus	·05 ,,
Silica	·03 ,,

The electrical conductivity is thus very high; the resistance is not more than 6·4 times that of pure copper.

The positive conductor-rail is carried on specially shaped insulators mounted on the ends of the sleepers close to the wall of the tube, while the negative rail is placed centrally on a lower type of insulator between the track rails. The positive insulator is of the peculiar shape which may be seen in Figs. 5 and 7, and has been designed to conform to the curve of the tube and to lie close to it. The clearance between the flanges of the segments of the tube and the conductor rail is only 2½ in. The insulators are of vitrified earthenware manufactured by Doulton and Company, and are fastened to the sleepers by malleable iron clips with felt pads below them. The negative rail insulator is a square solid block with a groove in the centre for the rail, and it is held down in a similar way.

The conductor-rail joints have each four bonds, two long and two short on each side. They are of the flexible plaited wire type, and were supplied by the American Steel and Wire Company. As will be seen from Fig. 7, the short bonds are placed inside the loops of the long ones.

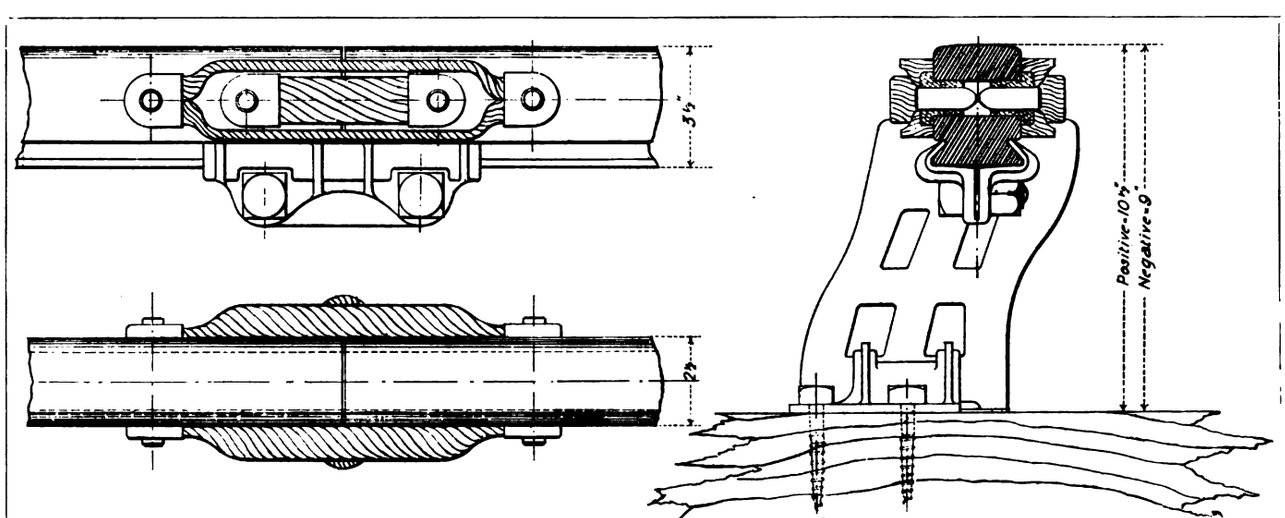

Fig. 7.—Conductor Rail Joint and Positive Conductor and Insulator.

FEEDING ARRANGEMENTS.

The high and low-tension feeder cable arrangements are comparatively simple, as there are only three sub-stations on the railway, viz., at Charing Cross, St. George's Circus, and Baker Street. The conductor rails are divided into long sections so that the low-tension feeders are not of great length. Only two high-tension cables run along each side of the railway to St.

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George's Circus and Baker Street respectively. They are hung on the tunnel walls on iron brackets which are bolted to the flanges of the rings of the tubes. Four low-tension cables also run along each side supported on separate brackets. These cables are for the lifts at the stations, for lighting, and for telephones. The high-tension cables were supplied by the Western Electric Company, and amount in all to some 15 or 16 miles in length. They are of the three core, paper-insulated, lead-covered type, of 37/15 guage, and in all respects similar to those described in our recent article on the District Railway Electrification.

SUB-STATIONS.

The chief sub-station for the railway is the underground one at Charing Cross, which also supplies the District Railway, and the Charing Cross, Euston, and Hampstead Railway. This sub-station was fully described in the article in our issue of February 9 last. The other two sub-stations, one in the depôt at St. George's Circus and the other at Baker Street, have arrangements as to incoming high-tension cables, out-going low-tension cables, switchboards, static transformers, rotary converters, etc., similar to those in the District Railway sub-stations. The St. George's Circus and Baker Street sub-stations have each three converters of 800 KW. each. The 11,000-volt cables, as explained in the article already referred to, are brought from the Chelsea power-station along the tunnel walls of the District Railway to Charing Cross. The low-tension cables feeding the adjoining part of the Baker Street and Waterloo line, are connected to the bus-bars of the Charing Cross sub-station. The high-tension cables for St. George's Circus and Baker Street are taken down a shaft at Charing Cross to the railway below, and are carried along the sides of the tube as previously described. The whole apparatus in the sub-stations was supplied by the British Westinghouse Company, under the supervision of Mr. S. F. Fortenbaugh.

PASSENGER STATIONS.

The passenger station buildings and the interior walls of the stations themselves have been designed by Mr. Leslie W. Green, A.R.I.B.A., and they present a very handsome appearance. The ground plans of the buildings vary in shape and size according to the site available, but the elevations of those above ground are similar. As will be seen from Figs. 8 and 9, these stations consist of a spacious ground floor with a mezzanine floor above, the entrances, exits, and windows being schemed to form a series of spacious arches. The roofs are left flat, so that additional storeys for occupation as offices or dwellings can be erected when desired. The structure consists of a steel frame-work which is clothed with terra-cotta glazed blocks of a dark but brilliant ruby red colour. The large gilded letters forming the name of the station are in one piece with successive blocks and stand out in bold relief. These names, which will be illuminated at night by arc lamps, run along above the entrances. The entrances and the exits are very wide, and the booking halls also are spacious. Some of the stations have two lift shafts with two lifts in each, while others have only one such shaft, but with three lifts in it. The diameter of the former shafts is 23 ft. and of the latter 30 ft. The lift cage bodies are of steel, and all parts are non-flammable. The total number of electric lifts to be used is 37, and these are being installed by the Otis Elevator Company. Fig. 10 shows an approach to the lifts at the low level, Fig. 11 the typical subway construction. All the station buildings are fire-proof, the only wood employed in them being the joinery of doors and windows and of the lift enclosures, which is of teak, uninflammable.

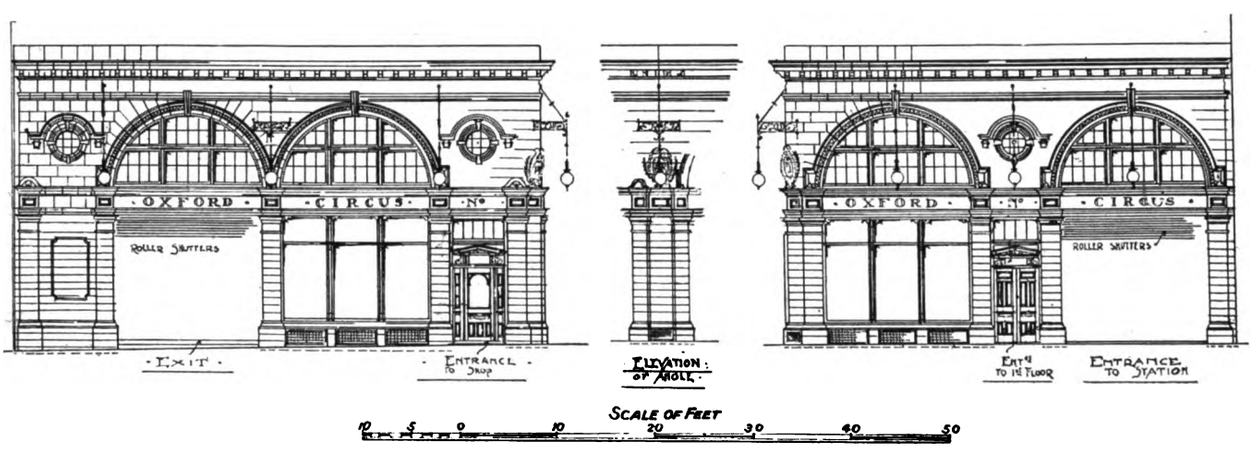

Fig. 8. Elevation of Station.

Each station has also a staircase shaft 18 ft. in diameter. Down the centre of this shaft is an iron tube 4 ft. 6 in. in diameter, used for ventilating the tunnels by means of a powerful exhaust fan. The whole of the air in the tunnels can be changed once in an hour, so that there ought to be no complaint of poor ventilation. The staircase is a spiral, occupying the wide annular space between the ventilating tube and the walls of the shaft. The lift and ventilating work is under the supervision of Mr. G. Rosenbusch.

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The Waterloo station, in York Road, has only an entrance gate, with flanking terra-cotta work on each side, to a subway leading to the booking hall, which is underground. At Baker Street the passenger entrance is below the ground level so as to communicate readily with the Metropolitan Railway. The electric sub-station here is placed above the booking hall and lifts, and is slightly above the ground level. The Trafalgar Square and Regent's Park stations are entirely underground. The former is under the south-east corner of the square, and has subways leading to the corner of the Strand at Morley's Hotel on the one hand and to Cockspur Street on the other. The Regent's Park station is under the flower beds in Park Crescent gardens. These underground stations are excavated chambers containing the booking offices and entrances to the lifts and staircases. They are approached by short stairs.

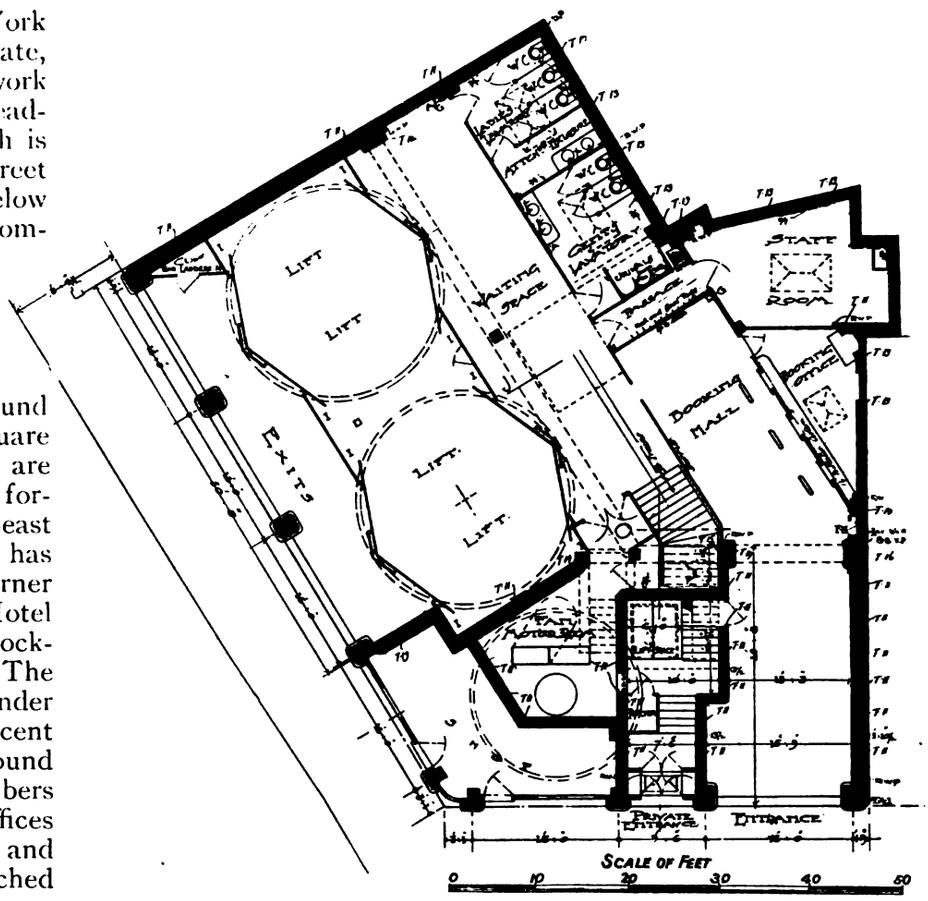

Fig. 9. Plan of Elephant and Castle Station.

The station platforms are of concrete, with stone-ware edging, similar to the new platforms on the District Railway. The walls are lined with white enamelled tiles, while the upper part of the arch is painted white. The name of the station, together with a scheme of wall decoration, is picked out in coloured tiles, forming part of the wall surface. A different colour is used for each station, so that habitual passengers on the railway will speedily be able to tell what station they are at without having to look for the name. On an ordinary open-air railway, the regular traveller recognises stations by their appearance or surroundings, but as there is no aid of this kind on a tube railway, the plan of using different colours for the names and decorations has been adopted, and it ought to prove very useful.

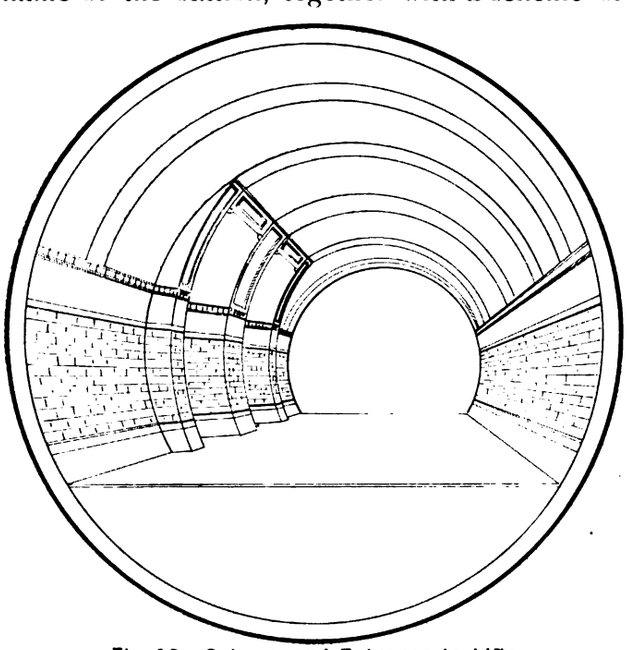

Fig. 10. Subway and Entrance to Lifts.

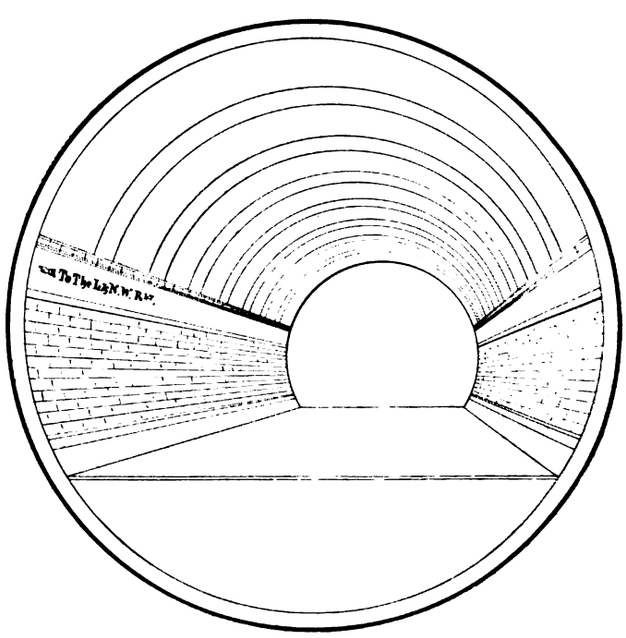

Fig. 11. Typical Subway Construction.

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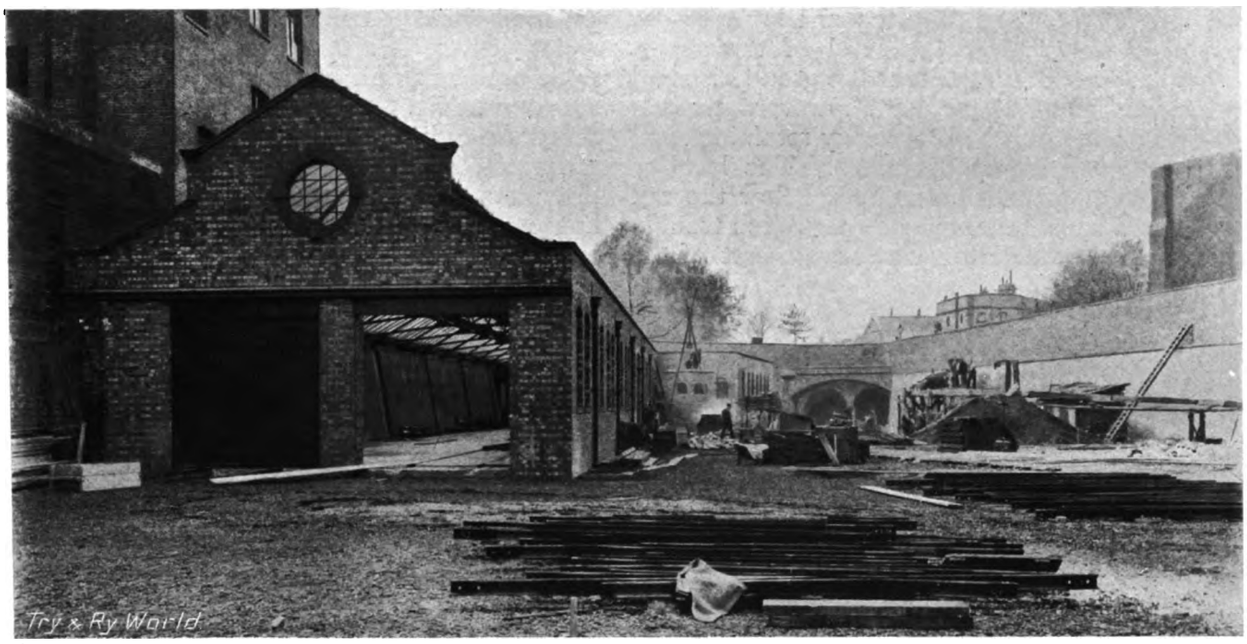

Fig. 12. Depot Looking West.

ST. GEORGE'S CIRCUS DEPOT.

An extensive site occupied by the Royal Blind School at St. George's Circus, near the Elephant and Castle, was acquired for the purposes of a depôt for the railway. The land here was expensive, but less so than it would be in many districts along the route of the railway. The contract for the depôt work was given to Messrs. Mowlem and Company, and last year the buildings were demolished and excavation started. At present the excavation work is nearly completed and the greater part of the buildings has been erected. The accompanying plan (Fig. 13) shows the general lay-out. The extreme length of the ground is about 700 ft., and the greatest breadth 324 ft. A large portion of the ground will be occupied by sidings for the accommodation of trains, there being altogether 14 tracks, all communicating with an incline which runs from the west end of the depôt (Fig. 12) down a tunnel to the railway below. There is also another tunnel, with a dead end, running for a short distance parallel to this, and to be used for shunting purposes. The whole area

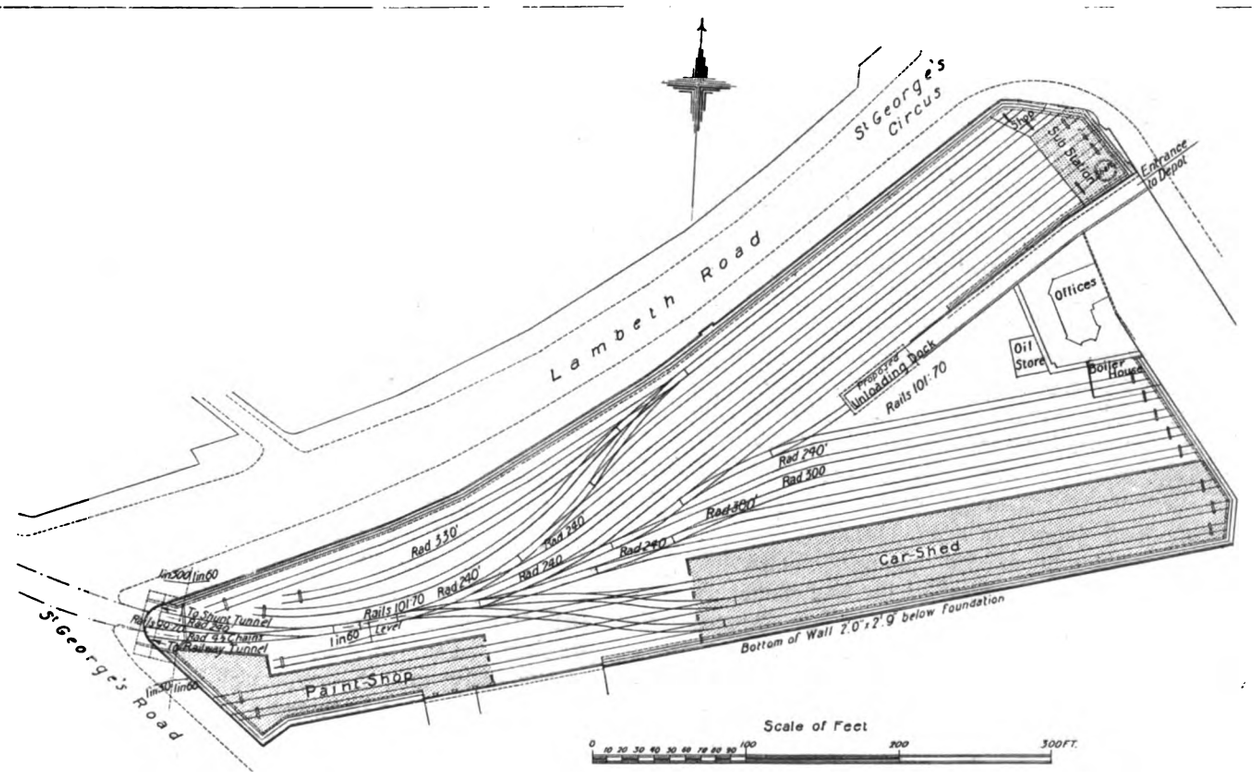

Fig. 13. St. George's Circus Depot.

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has been dug out, so that the rail level of the sidings is 14 ft. below the level of the street. The work was not difficult, as the ground is sand and gravel. The latter fact, however, necessitated the construction of a heavy retaining wall of concrete all round the area. The level of underground water is about 3 ft. below the rail level, there has, therefore, not been much trouble from water coming in. The lowest part of the work which has to remain open is the bottom of the inspection pit in the car shed, which is about a foot below the underground water line, so the pit has been made water-tight by an asphalte lining. The ground is rather low to drain the rain water from the depôt directly into the local main sewer, so the water is drained close to the sewer, and then pumped into it by two electrically driven pumps. The rain water from the roof of the car shed and the drainage from the office building do not require pumping, as they come from a higher level and are sent into another sewer in St. George's Circus.

The buildings upon the site include a car shed, paint shop, sub-station, boiler-house, and offices, the last of which consist of an old dwelling-house which is being remodelled internally. There is also a small detached building to be used as an oil and paint store, and at the corner next St. George's Circus some one-storey shops are to be erected. The northern frontage is formed by a brick wall. As is indicated on the plan, the shops, sub-station, and boiler-house are carried on stanchions, and are erected on the street level, so that the railway tracks can be carried underneath them.

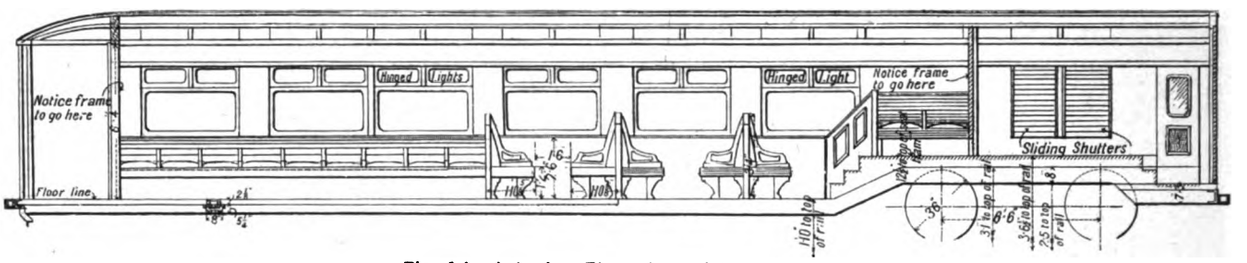

Fig. 14. Interior Elevation of Motor Car.

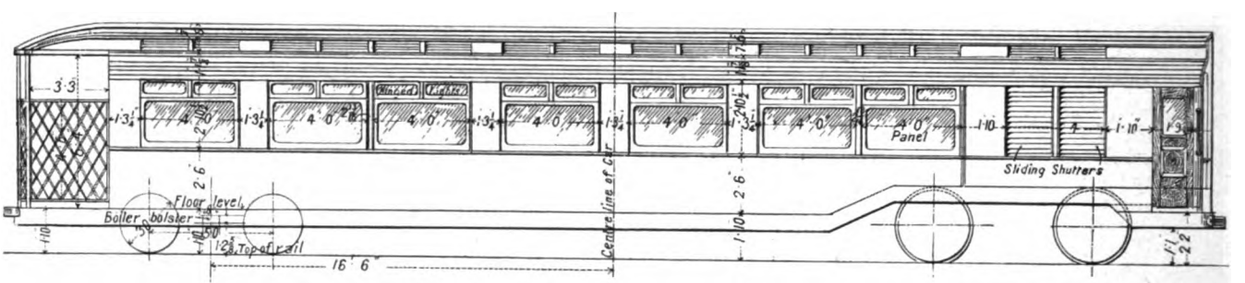

Fig. 15.—Exterior Elevation of Motor Car.

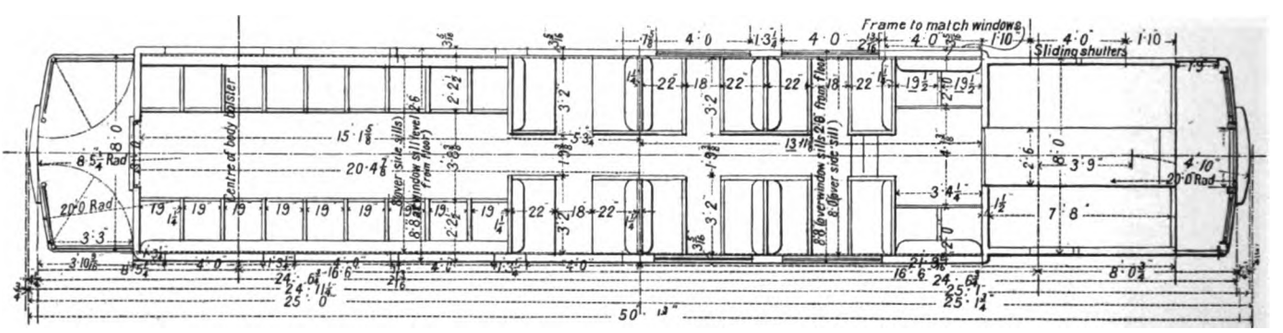

Fig. 16.—Seating and Floor Plan of Motor Car.

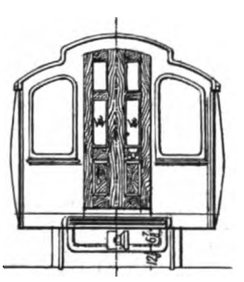

Fig. 17.—End Elevation of Motor Car.

The car shed (Fig. 13), which has three tracks in it, is 350 ft. long by 53 ft. wide, and will hold three trains at a time. The height from the rail level to the eaves is 28 ft., and to the ridge of the roof 41 ft. The side of the building next the retaining wall is on the lean-to principle, the lean-to being supported from the main stanchions. The walls are of red brick, and the entire roof is covered with Mellowes glazing. The pit, which is under two of the tracks only, is 4 ft. deep and is lined with concrete. The floor between the tracks is supported on iron stanchions. A number of repairing tools and other plant are being fitted up along the north side of the shed, including a pneumatic

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hammer, forges, wheel and other lathes, planer, radial drilling machine, grinders, etc. At the west end is the armature winding room.

The paint shop, which has two tracks without a pit, is 174 ft. long by 30 ft. wide, 14 ft. high to the top of the parapet, and 24 ft. 6 in. to the ridge of the roof. Like the car shed it is a plain brick building with a "Mellowes" glass roof. As it is comparatively narrow, there are no stanchions, the roof trusses running across from the one wall to the other.

The sub-station has been already referred to when dealing with that branch of the subject. At this particular sub-station, however, a shaft 12 ft. 7 in. in diameter is sunk down to the railway tunnels below. Inside it is a smaller shaft 4 ft. 6 in. in diameter, with a ventilating fan at the floor level. The ventilating shaft is carried up to the roof of the building. Between the two shafts a spiral stair runs down to the railway.

ROLLING STOCK.

The cars to be used on the Baker Street and Waterloo Railway differ from those employed on other lines in the important fact that they are almost entirely composed of steel. This is one of the precautions taken to render everything about the railway fire-proof. The cars are being built by the American Car and Foundry Company, and are similar in principle to the steel cars constructed by the same Company for the New York Subway. While the parts are manufactured in the United States, the fitting of them together and the whole erection work are being done in works which the Company have started for the purpose at Trafford Park, Manchester. In general appearance these vehicles do not differ materially from cars built of wood, but the method of supporting the floor is radically different. The sides of the car body form steel plate girders of great depth, and the floor is supported from these by steel diagonal ties. The framing is of steel angles, and the floors as well as the sides are of steel plate. The whole construction is of such strength as to be well able to withstand shock from collision. The only wood employed, and that very sparingly, is for some of the internal fittings, and this wood has been treated by the non-flammable process so as to render it incombustible.

The drawings (Figs. 14 to 17) show clearly the general arrangement of the cars. 108 of them are at present on order, and six cars will go to the standard train. There will be a motor car at each end, with four trailer cars between. All the cars are of the same dimensions, namely: 50 ft. long over all; 33 ft. between bogie centres; 8 ft. 8 in. in width; and 9 ft. 5¾ in. high from the rail level. Both longitudinal and transverse seats will be used, as shown in Fig. 16, and the trailer car will seat 52 passengers—36 on the longitudinal and 16 on the transverse seats. The motor car has seats for 46 passengers, the remaining space being taken up by the driver's cab and the electric control apparatus. The drawings show the motor car, but in the case of the trailer both ends are the same as the trail end of the motor car.

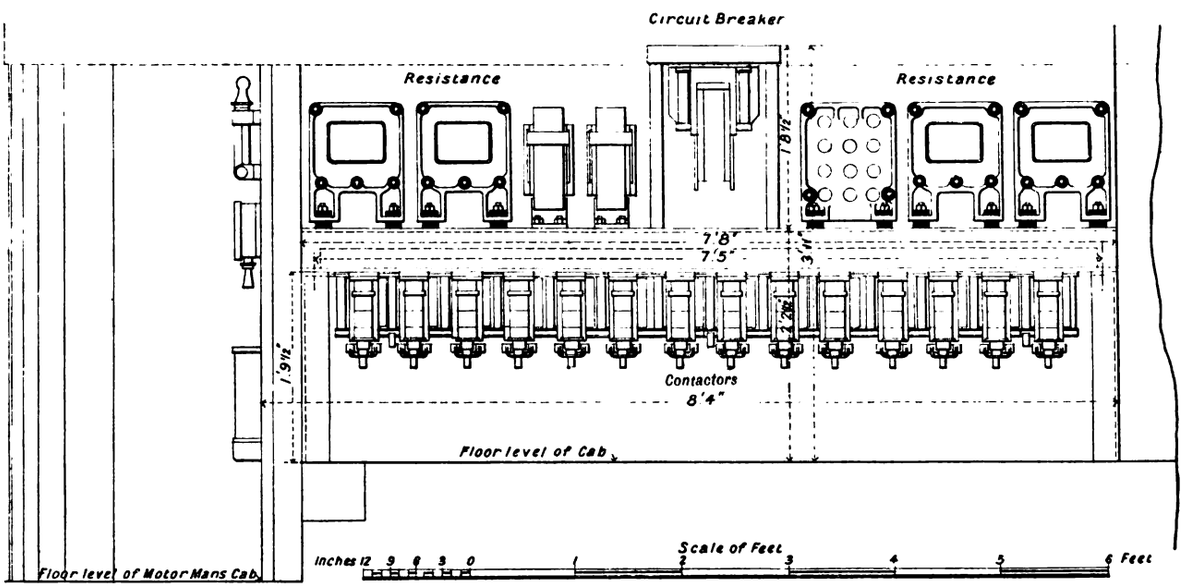

Fig. 18.—Elevation of Control Apparatus.

Stearn and Ward's patent automatic vertical-plane drawbar, which is employed, is of considerable interest. It is similar to that used on the new rolling stock of the Metropolitan District Railway, and it has a freedom of action like that of the standard drawbar on American trunk lines. It provides an automatic coupling with a double lock. Each drawbar locks into the one facing it, and if one is unlocked there is still the coupling, giving a double security. The wearing parts are of manganese steel, and the face of the buffer is deeply corrugated to prevent riding up in case of collision. The centre plates work on ball bearings.

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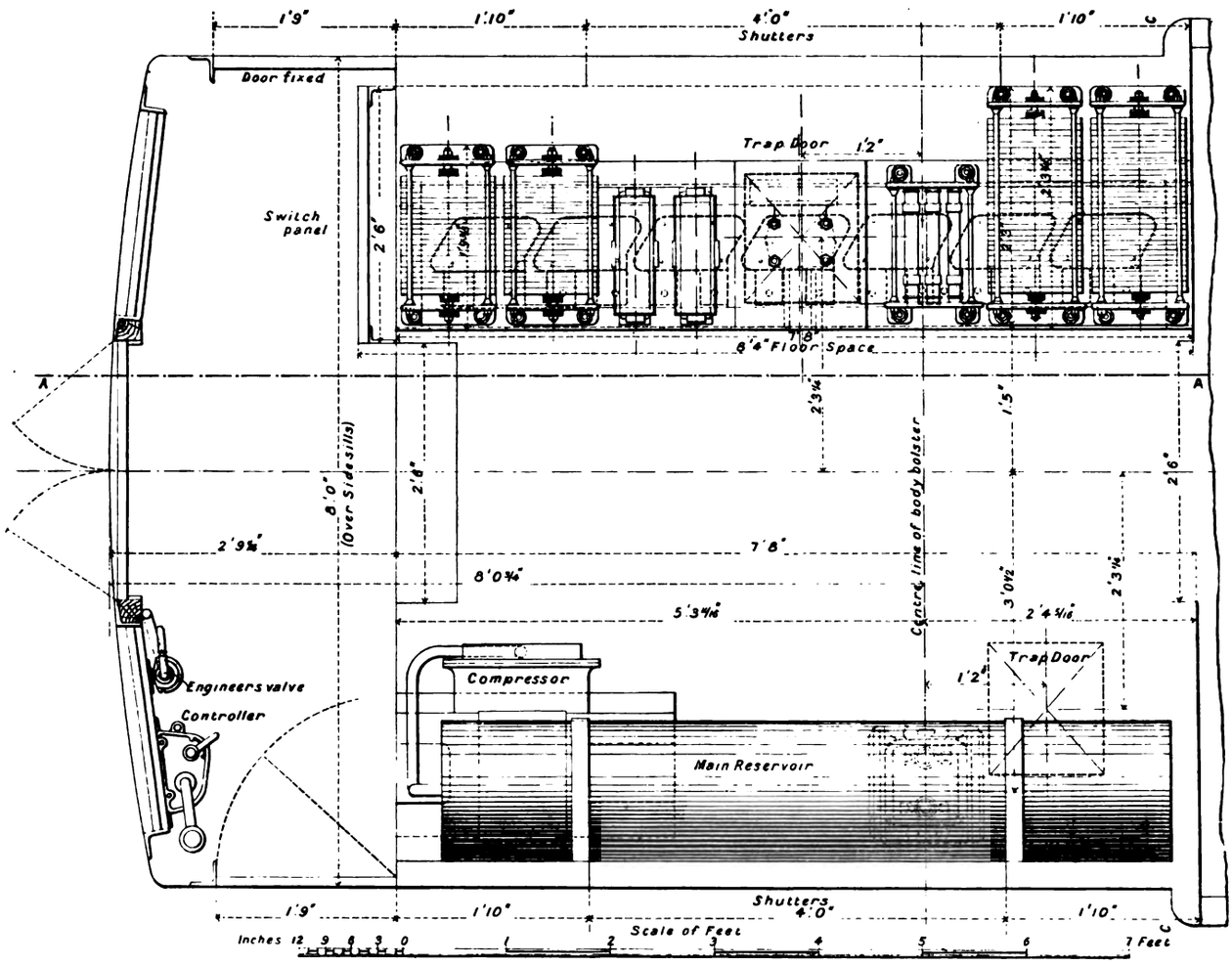

Fig. 19.—Plan of Control Apparatus.

The motor trucks, one of which is on each motor car, have 36 in. wheels, and they are identical in design with those fitted to the motor cars on the District Railway, which were described and illustrated in our issue of February 9 last. The car body, however, is different; owing to the limited head room in a tube railway it is necessary to keep the floor of the car as low as possible, and in order to get the motor truck, motors, and large wheels into the space the floor of the car above the truck is raised as shown in the drawing. This method of construction, it may be remembered, is used on the motor cars on the Waterloo and City Railway. The rest of the floor of the car is only 22 in. above the rails.

The trailer trucks differ from those used elsewhere, and they have been specially designed for the particular conditions. Their style may be gathered from Fig. 21 to 23. It will be noticed that the weight of the car is hung from below the level of the axles instead of being supported above that level. The truck frame is made as low as possible, to give room for the floor frame inside. There is no elevation of the floor of the car above the truck, and the bottom of the truck side frame is only 6 in. above the rail level. The wheels are 30 in. in diameter, and the wheel centres are 5 ft. apart. Both motor and trailer trucks have been made by the builders of the cars.

SCHEDULE OF TRAIL TRUCK DETAILS.

Material.	Index.	Description.
Mild steel	1	Axle.
C. and M. steel	2	Wheel.
Mild steel	3	Truck side frame (outer).
,, ,, ...	4	,, ,, ,, (inner).
Cast steel	5	Pedestal.
Mall. C. Iron	6	Journal box.
Cast steel	7	,, ,, thrust plate.
Bronze	8	,, ,, ,, ,, liner.
,, ...	9	,, bearing
Cast steel	10	,, ,, wedge.
Elm	11	,, box dust guard.
Mall. C. Iron	12	Distance piece bolster housing.
Mild steel	13	Bolster housing plates.
Cast steel	14	Swing bolster.
,, ,, ...	15	Bolster housing plate distance piece.
Mild ,, ...	16	Spring plank.
,, ,, ...	17	,, ,, guards.
Cast ,, ...	18	,, ,, bearing pocket.
Steel plate	19	,, ,, adjustment liner.
Mild steel...	20	,, ,, hanger bracket.
,, ,, ...	21	,, ,, pins top.
,, ,, ...	22	,, ,, ,, bottom.
Cast ,, ...	23	,, ,, hangers.
Mall. C. iron	24	Bracket for brake link beam.
Mild steel	25	Brake link beam live end.
,, ,, ...	26	,, ,, ,, dead end.
Spring ,, ...	27	,, beam release spring.
,, ,, ...	28	,, ,, ,, ,, packing.
Mall. C. iron	29	,, ,, link bracket.
Mild steel...	30	,, ,, link.
Cast ,, ...	31	,, head.
Grey C. iron	32	,, shoe.
Mild steel...	33	,, head and shoe key.
,, ,, ...	34	,, beam.
,, ,, ...	35	,, rod yoke.
Cast iron	36	,, ,, ,, roller.
Mild steel...	37	,, ,, ,, ,, pin.
Mall. C. iron	38	,, ,, ,, bracket.
Mild steel...	39	,, ,, (auxiliary lever to yoke).
Mall. C. iron	40	,, auxiliary lever fulcrum.
Mild steel	41	,, ,, ,, and live lever.
,, ,, ...	42	,, rod between auxiliary and live levers.
Mall. C. iron	43	,, live lever guide.
,, ,, ...	44	,, ,, ,, link to brake beam.
Mild steel...	45	,, rod, live to dead lever
Cast ,, ...	46	,, ,, adjustment ,,
Mall. C. iron	47	,, dead lever link to brake beam.
Mild steel	48	,, dead lever.
Mall. C. iron	49	,, ,, ,, fulcrum.
Mild steel	50	Cotter pins for 35, 39, 34, 44, 47.
,, ,, ...	51	,, ,, for 48, 49.
Spring ,, ...	52	Spiral equalising spring.
,, ,, ...	53	Elliptical spring.
Mild ,, ...	54	Cotter pins for 40.

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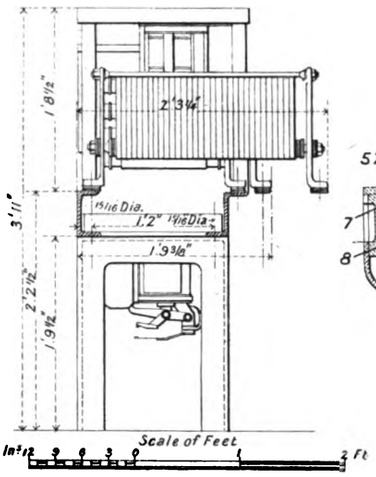

Fig. 20.—Cross Section of Control Apparatus.

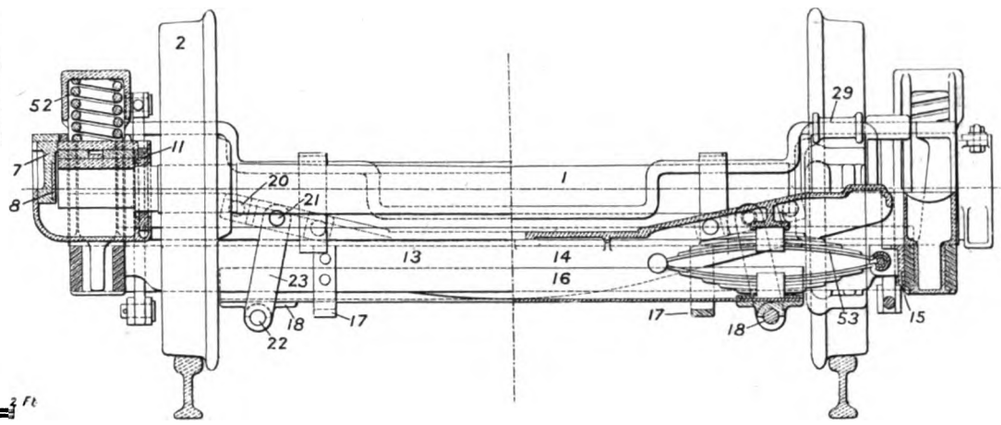

Fig. 21.—Cross Section of Trailer Truck.

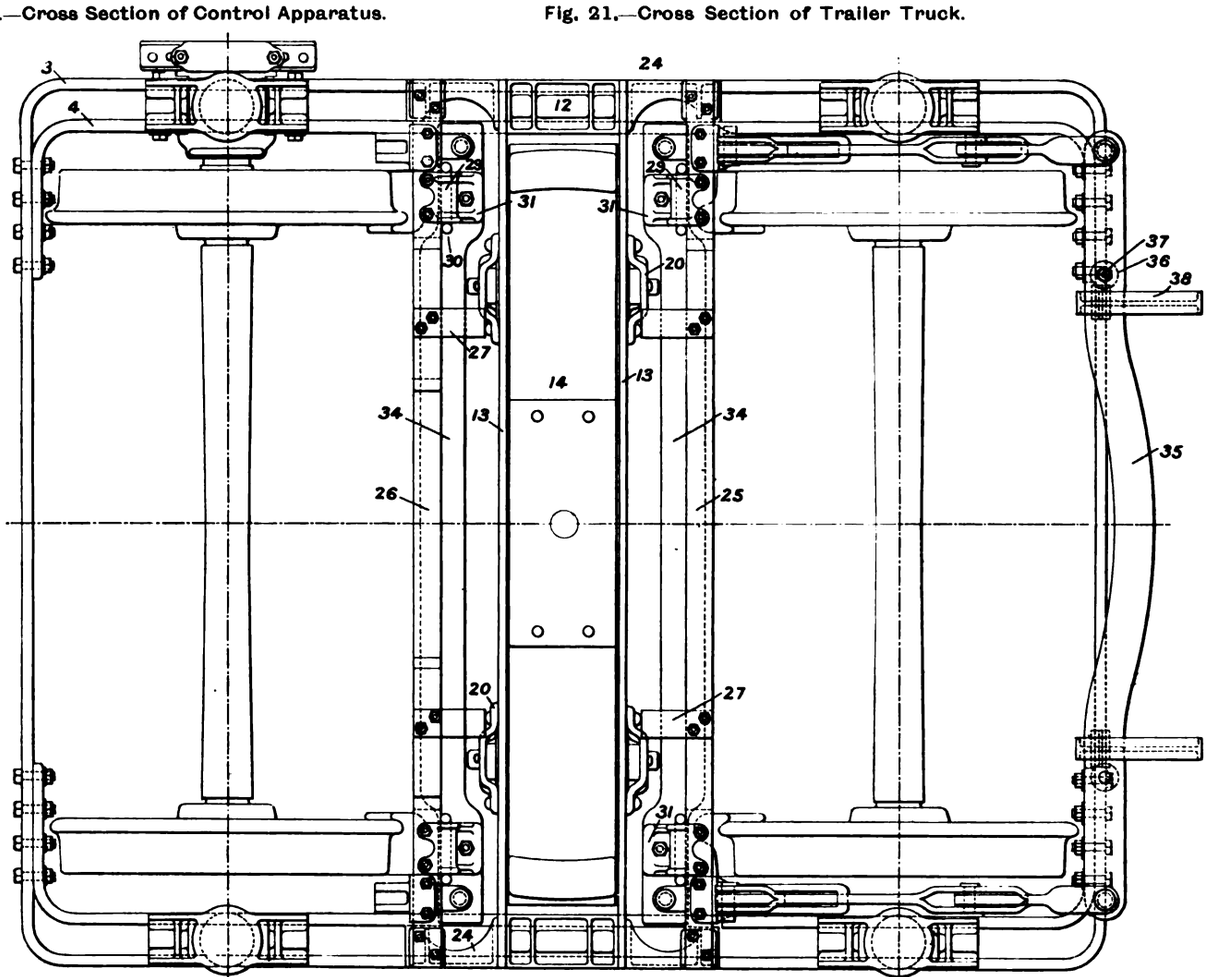

Fig. 22.—Plan of Trailer Truck.

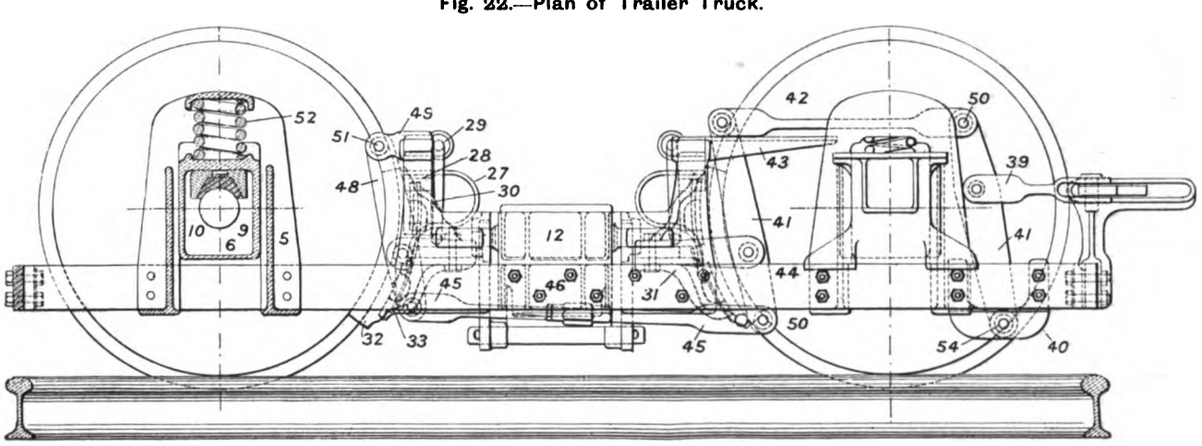

Fig. 23. Elevation of Trailer Truck.

(The Schedule of Trail Truck Details is given on page 501).

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The electric equipment of the trains is very similar to that employed on the District Railway, and described in the article on that installation already referred to. The Sprague-Thomson-Houston multiple-unit control is to be used throughout, but the whole of the control apparatus is contained in the driver's cab of each motor car instead of part of it being under the cars. Figs. 18 and 20 show in elevation and section the arrangement on one side of the central aisle of the master controller, resistances, contactors, etc. The only part of the electric apparatus on the other side of the aisle is the reverser, and along with it is the Westinghouse automatic pressure brake apparatus, including the air reservoir. The whole of the electrical gear is carried on and practically surrounded by slate slabs. The contactors, as shown in Fig. 20, are supported from a frame of angle-iron above. Fig. 19 is a general plan. Besides the Westinghouse brake, a hand-brake is also fitted.

The control cable runs the length of the train in the usual way, but of course each motor car is fitted with its own shoes running on the positive and negative conductor rails, so that each motor car picks up its own current. The control circuit is supplied with current normally from the shoes of the front car. There is, however, a double-pole throw-over switch installed in each car, by means of which the control circuit may be supplied with current from the shoes of the rear motor car through the lighting mains, should the shoes of the front motor car be over a gap while the train is standing. No driving power cable runs through the train.

There are two B.T.-H. 69 motors of 200 H.P. each on the driving truck of each motor car, giving 800 H.P. per train. These motors and their trucks will be interchangeable with those on the District Railway trains, also with those on the Great Northern, Piccadilly and Brompton Railway trains, and on the Charing Cross, Euston, and Hampstead Railway trains, as soon as the two latter lines are in operation. The same interchangeability will apply to the brake rigging.

Each car will be lighted by 20 electric glow lamps of 16 candle power each, arranged on four circuits. The head lights outside are independent of the internal lighting. A pair of lighting mains are carried along one side of the train from one motor car, and a pair along the other side from the other motor car. Half the lights in each car are fed from the one set of mains and half from the other. There is no cross connection between the two sets of lighting mains, so that it is not possible accidentally to join the shoes of the front car to those of the rear car through the lighting mains. By this arrangement half the lights in each car will go out as the train crosses a gap in the conductor rails greater than the span of the shoes of the front car, and will re-light long before the other half of the lights go out as the shoes of the rear car come over the same gap.

The execution of the whole work connected with the rolling stock is supervised by Mr. F. D. Ward, master mechanic of the Underground Electric Railways Company.

SIGNALLING.

Fig. 24 is a diagram showing the arrangement of the signals on the railway. It is divided for convenience-sake into two parts, and it is not drawn to scale, but it shows the general arrangement. The system to be employed is the same as that which is coming into use on the Metropolitan District Railway. This was described in our recent article on the electrication of that line. It will be remembered that it comprises both automatic and semi-automatic working of signals and points, and that the scheme of interlocking is fully worked out. Each train, under ordinary circumstances, actually works the signals as it proceeds, every signal being automatically thrown to "danger" behind it. The track rails are bonded to carry the low-tension current for working the system, and compressed air for the signal pneumatic motors is provided from the substations. The Westinghouse Brake Company have supplied the installation, which is, of course, of a much simpler character than that on the District Railway, as there are no junctions to deal with.

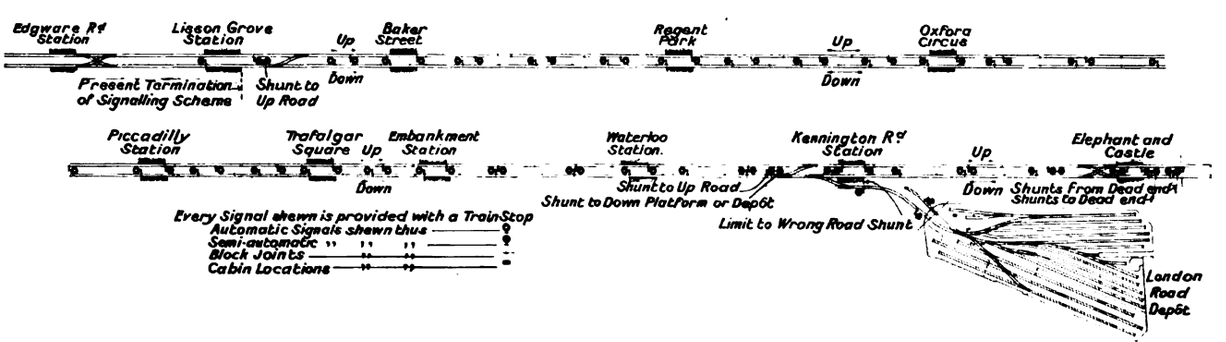

Fig. 24. Plan of Arrangement of Signals.

For the facilities and information placed at our disposal we have to express our indebtedness to Mr. James R. Chapman, engineer-in-chief and general manager of the Underground Electric Railways Company, of London; Mr. H. H. Dalrymple Hay, Mr. W. E. Hanson, Mr. Z. E. Knapp, Mr. F. D. Ward, and Mr. G. Rosenbusch; and to Mr. Leslie W. Green, architect for the passenger stations.

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THE TRAMWAY SYSTEM OF CALCUTTA.

Owing to more immediate interests nearer home, it was not until a few years ago that attention was directed to the possibilities of lucrative tramway undertakings in the East. Electric traction has infused new life into systems which formerly employed steam and animal traction, and the success of such conversions has been followed by numerous concessions for electric tramways in places such as Hong Kong, Singapore, Manilla, Rangoon, Mandalay, Tokio, Batavia, Penang, and Colombo. The largest and most important of the tramway systems in the East is that of Calcutta, and it is of more than usual interest, having regard to the conditions under which it operates.

It is hardly necessary to say that Calcutta, the metropolis of India and the seat of Government, is one of the largest and most important cities of the East. It is a very large port, and the centre of the extensive Indian trade in tea and jute, general produce and merchandise.

On account of its low-lying position, an extensive system of artificial drainage has been adopted, and though fairly well carried out, is not nearly sufficient to cope with the extraordinary downpours during the rainy season, which flood the streets in certain sections of the city for the greater part of the day, sometimes to a depth of quite two feet and upwards. Another climatic condition which causes great damage and difficulty from a traffic point of view is the number of severe wind storms, approximating to cyclones, which sweep over the city at the beginning and the close of the rainy season (which lasts from the middle of June to the end of September), often with destructive effects, uprooting trees, unroofing houses, and causing general damage.

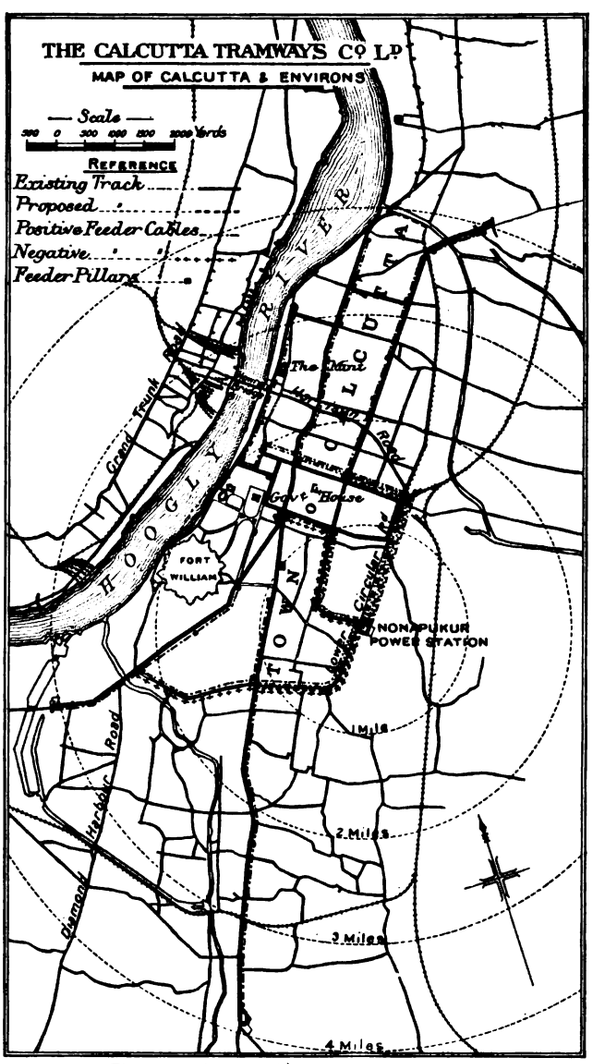

Fig. 1.—Plan of Calcutta Tramways.

Calcutta is divided into three parts: (1) The European business district, practically confined to an area of 250 acres, located in the west central portion of the city, bordering on the eastern bank of the River Hooghly; (2) the native residential and business district, situated in the northern part of the city; and (3) the European residential district, located in the southern portion of the city.

The total population, with certain adjoining suburbs, is about 1,000,000, which does not include the municipality of Howrah, on the opposite side of Hooghly River, having a population of 157,594, nor two other suburbs which will soon come within the tramway zone, and which have an additional population of 51,806. The total population can thus be put down at 1¼ millions.

In the native town, the streets, as in all Oriental cities, are narrow, and lined for the most part with unprepossessing houses and huts, which are very densely peopled, one ward having a density of 281 per acre, or 180,000 per square mile. Broad roads are, however, now being cut through the native quarters, and the congested districts, which have up till lately been the hotbed of epidemics and plague, are being opened out; this work is the beginning of a large improvement scheme upon which the Government has entered.

The southern European residential portion is traversed by wide and well-paved roads, lined with very commodious and roomy houses, which are inhabited for the most part by Europeans.

The European community does not differ essentially in composition from that of other large cities of the East (where there is an almost entire absence of the European artisan). The official element is very strong, and the professions in general are well represented, while there is a large number of European merchants. The total number of Europeans and allied races

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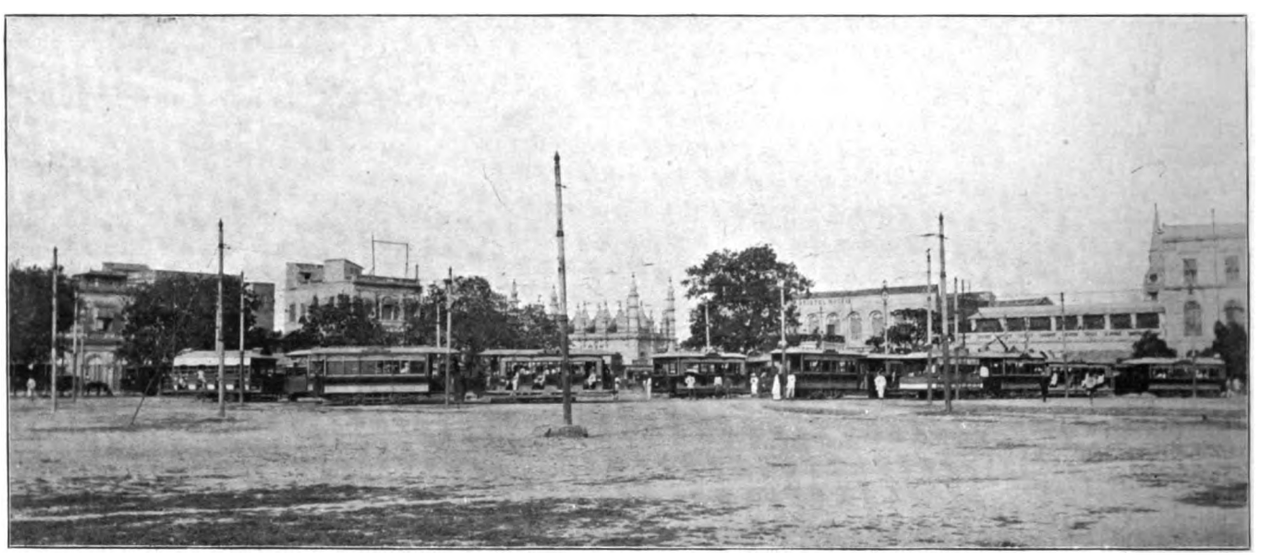
resident in Calcutta during the cold weather is approximately 14,000.

The Calcutta Tramways Company was registered in England on December 23, 1880, and operated its system by steam trains on the Kidderpore section, and by horse cars on the remaining section, until 1901, when the original concession expired. In 1899 an agreement was entered into with the Corporation, whereby the Company was granted a new concession for 30 years from January 1, 1901, in consideration of the Company's converting the system from horse to electric traction within three years.

The capital authorised is £700,000 in £5 ordinary shares, all of which have been issued, in addition to which there is a 4½ per cent. debenture issue of £350,000. The company's head office is at 1, Queen Victoria Street, London, and in Calcutta its representative is Mr. Martyn Wells, managing agent, Mr. A. J. J. Pfeiffer being assistant manager and chief engineer.

the whole period of conversion from horse to electric traction, both the company's officials and the contractors received the greatest help and encouragement from the various Government and local authorities.

As already mentioned, the streets are narrow, especially in the native quarter and, as the bulk of the riding public are natives, the authorities very wisely sanctioned the laying of lines in the main native thoroughfares, although these are much narrower than those generally found in large cities of the West, but hardly more so than in some of the smaller old towns on the continent of Europe. The Chitpore Road, which forms one of two main arteries of the native section, is probably unique as regards density of traffic, including foot-passengers, carriages and carts, besides the electric cars, but even with this dense traffic the Western visitor is astonished to see how well and efficiently the tram service is kept up. The tracks in all narrow streets are laid as



Esplanade Junction.

THE SYSTEM.

The electrification of the system was carried out according to the most modern plans in everything as regards central station equipment, overhead and underground conductors, rolling stock, etc., and special attention in design was given to adapt the plant to the peculiarities of tropical and local conditions. The engineers and contractors were Messrs. Dick, Kerr and Company, of London and Preston, who executed all work except the buildings and the reconstruction of the permanent way, which was carried out by the company itself. All the rails, iron work, bonds, etc., for the permanent way work, were, however, furnished by Messrs. Dick, Kerr and Company. The entire conversion was creditably carried through in a comparatively short time, and the various parts of the plant have since then worked well under the most trying conditions.

It is very gratifying to note that throughout

much to the side as is possible, and the distance in many cases from the nearest rail to the kerb does not exceed 2 ft. This is necessary in order to give sufficient clearance on the other side of the tracks to accommodate at least one vehicle.

The entire area of the city is flat. There are no grades to speak of, except when crossing three bridges, the approaches to which do not exceed 150 to 200 yards, with grades of not more than 4 per cent.

As shown on the accompanying plan (Fig. 1), the present tramway routes, covering a total length of 23 route-miles, and double track throughout, all radiate from one small section of the city, in the west central portion bordering on the river, where the majority of the Government offices and European business houses are situated. This small district is the objective point of thousands of natives from all directions in and about Calcutta, who have business in the Courts and numerous offices. The cars on the various

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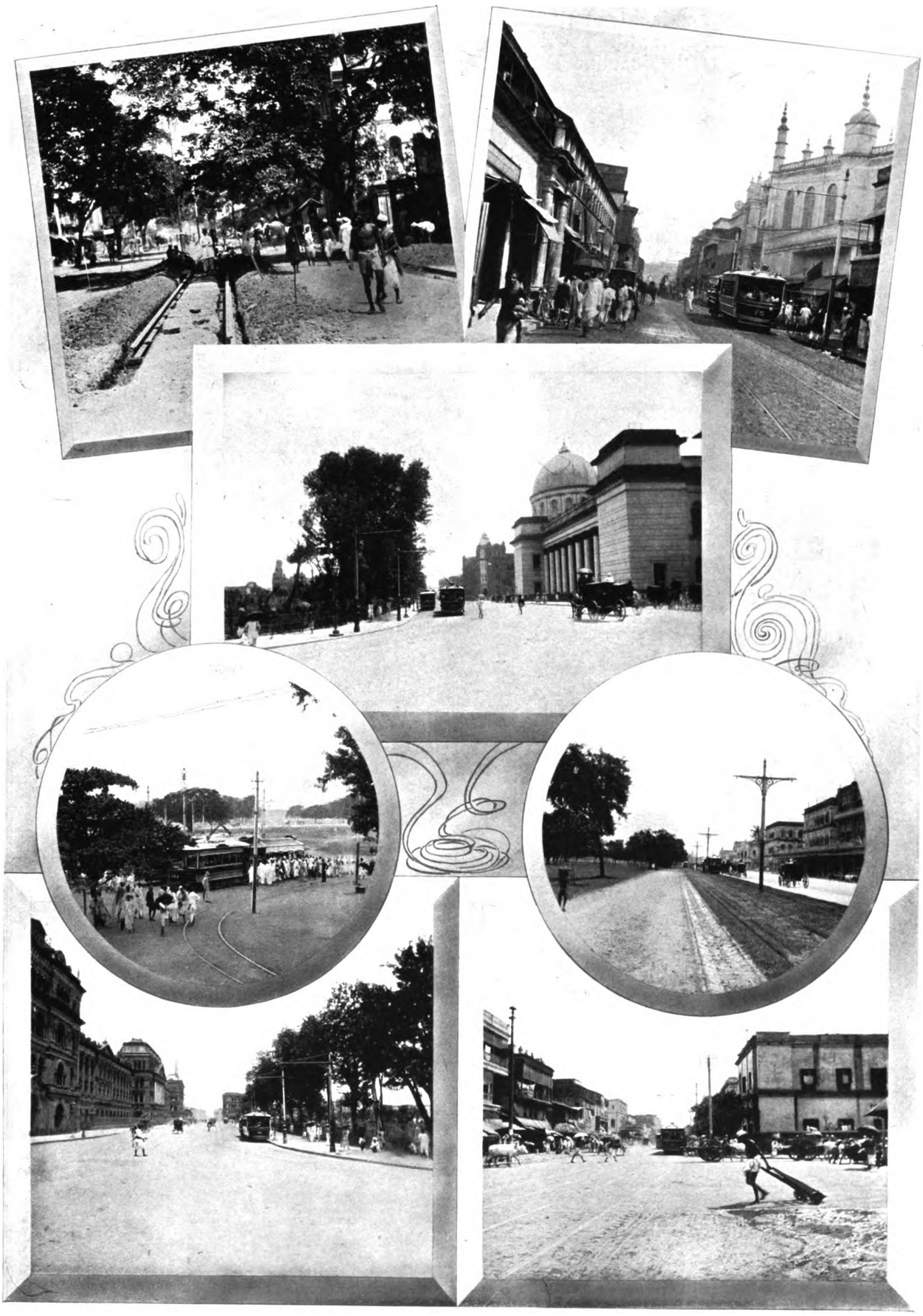

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lines are run to either one of two termini, one being at the loop near the High Court; the second, the Esplanade Junction, is at the intersection of Dhurrumtollah Street with Chowringhee Road, the latter forming the junction between the northern and southern lines. The number of cars at these two points is very large during the rush hours, trains following one another in close proximity. The number of trains arriving at these points per day amounts on an average to—

High Court	750
Esplanade Junction	1,150

The northern section of the city is served by three routes, the central portion by three, and the southern portion (including suburbs) by two, all double tracked.

A few years ago a fine large road (the Harrison Road), running east and west, was cut through from Sealdah Railway Station to the bank of the river at the Floating Bridge, which now forms the main artery of cross city traffic in the native district. A double line of track has just been laid down the centre of the road, and will shortly be opened for traffic.

There are eight main routes and these with two exceptions can be considered city lines. The Chowringhee line runs southward to a densely-populated suburb, Bhowanipore, touching upon the way the western extremity of the European residential zone. On this route there is also a famous Hindoo temple which attracts a constant native traffic throughout the year, and during certain holy festivals the service has to be doubled to cope with the rush.

The line to Kidderpore feeds the populous suburb which lies to the south near the river; it caters for the large traffic between the extensive docks and Calcutta, a traffic which is greatly augmented during the races on the Maidan course.

The total route mileage (all double track) at present is 24·75 with Harrison Road included. On the basis of a tributary population of approximately 800,000 the route mileage per 1,000 would be ·031 as against about ·08 found in England, and an average of about ·25 to ·30 found in the United States of America in cities of about one-third of the population of Calcutta. The low mileage per head is due to the congested condition of the native quarters, which do not cover anything like the area of an equally populated western city.

TRAFFIC.

All tramways in India have, of course, to depend mainly upon the natives for their earnings, since Europeans form but a very small part of the population and, in investigating the possible establishment of a system, due weight must be given to their characteristics, habits, average income, and occupations.

In Calcutta the average income of the native working man and labourer is not sufficient to permit him to ride freely and, in consequence, he is but a small factor in the earning powers of a tramway, the main fundamental revenue being derived from the business and professional classes and Government employees.

The native is a great litigant, and will spend any amount of money and time over the smallest case and, in consequence of this characteristic, the courts located in various parts of the city employ a great many clerks and other officers, and daily attract a large number of people, the major part of whom use the tramway.

Another class of rider is the clerk in European business houses and in Government offices. Native traders do considerable business among themselves in distinct parts of the city, in what are called bazaars, which afford constant interchange of traffic.

All the above constitute the steady riding factor, or regular traffic with two "rush" points per day, on which the tramways may depend. The "floating" traffic, which is by no means small, is created mainly by the temples of the Hindoos or mosques of the Mahommedans, which constantly attract extensive crowds for worship but which, on many days, especially on those which are holy or sacred, form the objective points of many thousands of devotees from the city as well as from the surrounding districts. This religious feature is a valuable asset in the earnings of all Eastern tramways, provided always that these objective points are sufficiently far removed from the centre of the native population to induce them to ride rather than walk.

The first line under electric traction in Calcutta was opened for regular service on March 27, 1902, and the entire system was operated electrically on November 20 of the same year. A large increase of traffic immediately followed the opening of each section; this, however was to be expected since, under steam and horse traction there was only one class for passengers and, owing to the severe climatic conditions of excessive heat and humidity during the summer months and the consequent exhaustion of the horses, even this service was not nearly sufficient to cater efficiently for the riding public. The total traffic revenue increase with electric traction over that of horse traction, after two years of operation, is about 75 per cent. This increase is due, not only to more accommodation furnished in the shape of extra car mileage for the second class passengers, but because the motor cars which serve the first class developed an altogether new source of revenue, since people are now riding who in past years never made use of the tramway; especially is this the case with Europeans and the better class of natives.

Car Service.—The car service, or rather train service, regulated carefully according to requirements, begins at 5 a.m. and ends at 10-30 p.m. The native being an early riser, traffic begins quite briskly in the morning, takes a sudden rise at 9-30 to 11 a.m. during the office traffic, falls

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off during the afternoon, increases rapidly again at 4-30 for the return office traffic, and is practically finished at 9-30 in the evening, since the native travels about but very little at night.

The maximum number of trains operated at one time during an ordinary week-day, on the present 46 miles of single track, is 132, this being increased to 145 on race days, and during the recent Pujah festival of the Hindus (corresponding to our Christmas in importance), the then full equipment of 151 trains was required, the traffic to the temple at Kalighat, from all parts of the city, being very large.

Although there are well recognised fixed stopping places on the system, it has not been found practicable to make use of them exclusively, on account of the very severe conditions of heat and rain, which make it necessary for the comfort of passengers to set them down and pick them up wherever they may require.

Staff.—The traffic staff is all native, with the exception of the superintendent and his two first assistants, who are Europeans. A considerable number are traffic employees from the old horse car days, and they had the experience which made their initiation into electrical traction comparatively easy. Drivers of old horse cars were taken on to act as motormen, and from the start acquitted themselves admirably. It is really astonishing to note with what skill and coolness they handle a heavy train in the narrow streets full of people and vehicular traffic and native conveyances. Conductors are checked and supervised very carefully by a comparatively large staff of checkers and inspectors, who are promoted from the ranks of conductors.

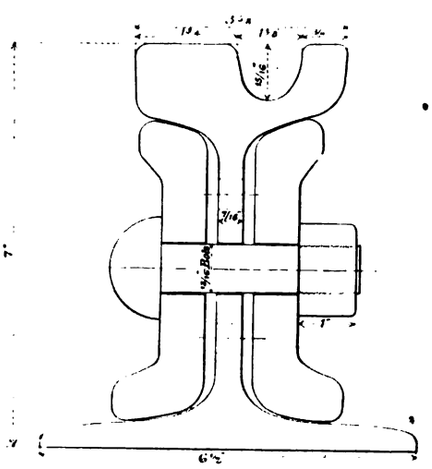

Fig. 2.—Section of Rail.

Statistics.—A few traffic results are herewith given which may be of interest to show how they compare with those found in the West:

Total number of passengers carried per year..	21,000,000
Total yearly train-miles run	3,300,000
Passengers per train-mile..	6·4
Average distance travelled per passenger ..	2 to 2¾ miles
Average fare per passenger	1·46d.
Traffic operating expense per train-mile ..	1·25d.

The operating expenditure per train-mile, as noted, is about 1·25d., which includes salaries and expenses for the superintendent, assistants, motormen and conductors, regulators, starters, cashiers, etc. This is about 40 per cent. of the results in England, and 30 per cent. of those in the United States.

PERMANENT WAY.

A considerable portion of the track in the early days of the company was single, with turnouts. This was found to be very unsatisfactory, especially in an Eastern city, where an accurate schedule timing, such as is required to give a satisfactory service with single track and turnouts, was practically impossible. The track was gradually doubled throughout, the last line being the Kidderpore section just before the introduction of electric traction.

Some of the reconstruction was started as far back as 1892, but the bulk of it was completed three or four years ago. The gauge of the track is the standard 4 ft. 8½ in. Girder rail was substituted for the old box rail throughout, the rail on some of the sections which were first reconstructed being 95 lb. per yard, with ¾ in. and ⅞ in. groove, but all the later types, and those which are now being used on extension work, consist of a 101 lb. rail, with 1⅛ in. groove, as shown in Fig. 2.

In spite of the heavy traffic to which some of the lines are subject, the track has stood well, and any sinking or subsidence has probably been due to the giving way of the sub-soil. The usual tie-bar construction is employed, five bars being provided on an average per rail length of 30 feet, each bar weighing 15¼ lb., including check-nuts and bolts.

The rail is embedded on a lime concrete stringer, having a width of 16 in. and a depth of 9 in. This concrete is made up of ten parts broken brick, 3 parts of ground brick, and two parts of slaked lime. The above method of making up concrete is prevalent in Calcutta, since broken stone is expensive, as is likewise good sharp sand, and the high price of Portland cement prohibits its use in this connection. The lime concrete with the above composition and material makes a very good substitute for the ordinary cement concrete, though more care is required to consolidate it, and a greater time is necessary to enable it to set properly.

The edges of the rails on all lines in the city are paved to a width of 18 in. on the outside of the double track rails and 9 in. on the inside, Indian granite setts being used. In some streets and parts of streets where the traffic is especially heavy, paving is carried straight across the double track to a width of 18 in. on the outside of the extreme rails. The setts are embedded in sand, and grouted with four parts of river sand and one of Portland cement.

In its agreement with the Corporation, the company undertakes to keep the roadway in proper repair to within 18 in. on the outside of the extreme rails.

Two No. 4/0 B. and S. Neptune bonds are used for every joint, the bonds spanning the fish plate and having a length of 2 ft. 6 in. The track is adequately cross-bonded.

OVERHEAD LINES AND CABLES.

The system is worked throughout by means of the overhead trolley, and on account of the

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peculiar conditions existing, a part of the lines had to be equipped for the side-running type. Of the 23 miles of route 20 per cent. is centre-pole construction, 30 per cent. is side-bracket construction, and 50 per cent. is span-wire construction.

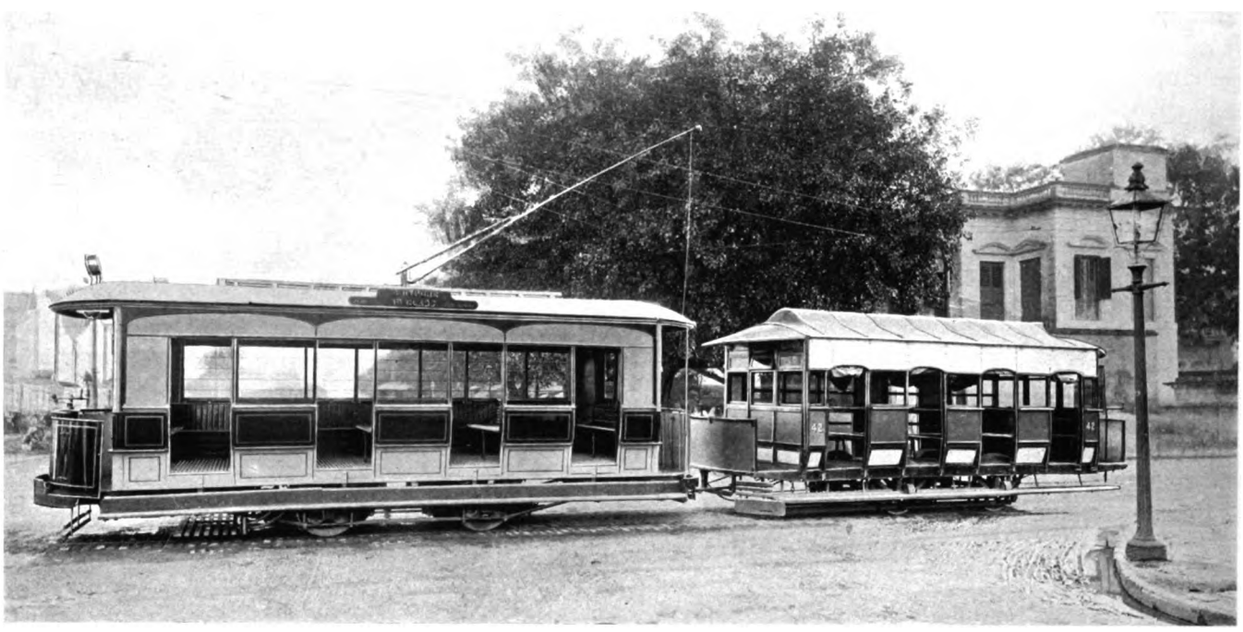
The poles used are made up of steel tubes, varying in thickness and weight according to the requirements of their location. Each is built up of three sections, socketed into each other, giving the general appearance of a gradual taper. The average distance between the poles varies from 100 ft. to 120 ft. on the straight.

	Weight.	Length.
Light poles	673 lb. ..	27 ft. 6 in
Heavy poles	1,032 lb. ..	27 ft. 6 in.

The brackets used on the side-running portions vary in length from 3 ft. for centre-pole to 15 ft. for side-pole construction, the interior diameter of the tubes being 2 in.

emanate from the power-house and connect to 43 feeder and section pillars distributed over the various routes. The return or negative cables are three in number, one of them having a cross section of ·7942 sq. in., and the other two ·3 sq. in. each.

All cables are paper-insulated and protected by heavy lead sheaths, and were laid underground in cast-iron troughs on the solid system, the troughs as a rule being located along the outside margin of the tramway right of way. The cables are supported in the troughs by wooden bridges, and the whole trough is filled in with a special pitch compound. The troughs themselves are laid in a trench varying from 16 in. to 24 in. in depth, according to the nature of the ground. This system of laying has given rise to difficulties due to the cast-iron covers of the troughs being too thin and easily pierced by the picks of excavators. Several burn-outs of cables have been



Open Motor Car and Trailer.

The trolley wire is of hard-drawn copper of 3/0 S.W.G., and is generally supported by double insulating hangers of the rigid suspension type, but flexible suspension has been substituted for these on that section of the Chowringhee lines where the speed attained is greater than the average, so as to lessen the effect of the blow on the ears. A similar improvement will be made on the Kidderpore line.

The angle of the trolley pole varies considerably on the different side-running sections, the maximum outreach, which is on the Chowringhee line, being 4 ft.

The general arrangement of the feeder system, both positive and negative, is so laid down that the majority of the feeding cables are led to the central point of the city, where all lines converge. There are nine positive feeder cables, varying in cross section from ·19 to ·6215 sq. in., which

traced to this cause and, to eliminate this danger as much as possible, in all cable laying earthenware troughs are now and will be used. In fixing upon the type of trough to be used, it was determined to employ a cover 1¼ in. thick. It has been found that this thickness will withstand ordinary negligence in the digging up of the roadway. In order to forestall any difficulties which might arise owing to the sinking of the unstable soil, these earthenware troughs, especially in cases when they will carry high-tension cables in connection with the plant extensions, are embedded on a concrete stringer 6 in. thick. The cables used for connecting from the feeder pillars to the trolley wires are 61/17 S.W.G., rubber insulated, heavily braided, and lead-covered. Each feeder pillar is made up of a cast-iron box, which is raised 2 ft. from the ground in those places where there is danger of

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the pillar being flooded by the rains. Each pillar contains the usual standard switches and connections mounted on a marble or slate switchboard.

ROLLING STOCK.

When converting from horse to electric traction, it was decided to adopt the train system, consisting of one motor and one trailer car, the former serving first-class passengers represented by Europeans and well-to-do natives who previously never made use of the tramways, and the latter providing accommodation for the old patrons. This system made it necessary to construct loops or triangles at various points of the lines for the turning of the trains.

At present there are 171 single-deck motor cars, of which 96 are of the open type and 75 of the closed type. The motor car bodies and equipments were made at the Preston works of Messrs. Dick, Kerr, and Company, and the trucks were furnished by Messrs. J. G. Brill and Company.

The car bodies are of plain strong construction, made to suit the climatic conditions, teak wood being used throughout, as it is impervious to the ravages of white ants. The closed cars have a total seating capacity of 27. The open-type cars, which have a seating capacity of 40 passengers, are single-ended with the entrance from one side only, this being dictated by the loop-system that was adopted.

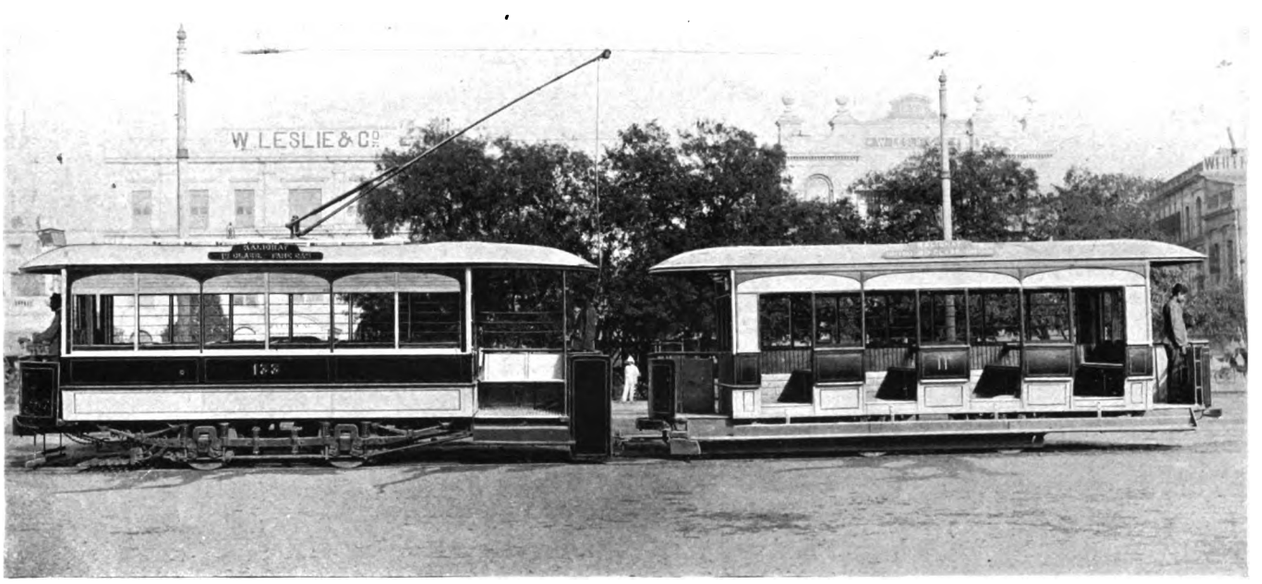
The electrical equipment for each motor-car, as manufactured by Messrs. Dick, Kerr, and Company, consists of two motors with one controller and all accessories. Each motor has a normal output of 25 H.P. under the standard rating. It may be pointed out that the motors have to stand very severe operating conditions owing to the heavy rains which, during the rainy season, flood certain parts of the city to a depth of several feet. Heavy showers come on so rapidly that the drainage system is incapable of satisfactorily coping with this excess of water. It is, therefore, difficult at times to get the cars out of the low-lying districts, as they become flooded in a remarkably short space of time.

POWER-STATION.

The situation of the power-station with respect to the tramway system can be seen on the plan and the general lay-out of the station plant on Fig. 3. The building is a brick structure covered on the outside and inside with sand plaster, the usual form of building construction prevalent in India. The chimney is constructed of brick, and has a height of 150 ft. The inside diameter at the top is 7 ft. 6 in., and the base of the chimney is 36 ft. square.

The equipment of the engine-room at present consists of 3 main-engine-dynamo units of the same design, in addition to which there is a supplementary unit of smaller capacity, suitable for supplying current during the hours when the traffic is light and, likewise, in working in conjunction with two of the large units to carry the maximum load in the station, thus leaving one large unit in reserve.

Engines.—The three large engines are of the horizontal cross-compound condensing type with dynamo and flywheel between the high and low-pressure sides of the engine. They are of the Yates and Thom type and run at 90 revolutions per minute, with a working pressure of 120 lb. per sq. in. and, under these conditions, the engines develop at their most economical operating point about 675 I.H.P. They are, however, capable of working satisfactorily up to 950 I.H.P., representing 25 per cent. overload. The cylinders are 21 in. and 40 in. in diameter, with a stroke of



Closed Motor Car and Trailer.

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3 ft. 6 in. The valve gear for working the admission valves is a well-tried release or trip gear of the improved "Dobson" type, consisting of hardened steel catch plates attached to blocks which are connected by links to the steam valve levers, and have also spindles or rams coupled to the dash-pot pistons.

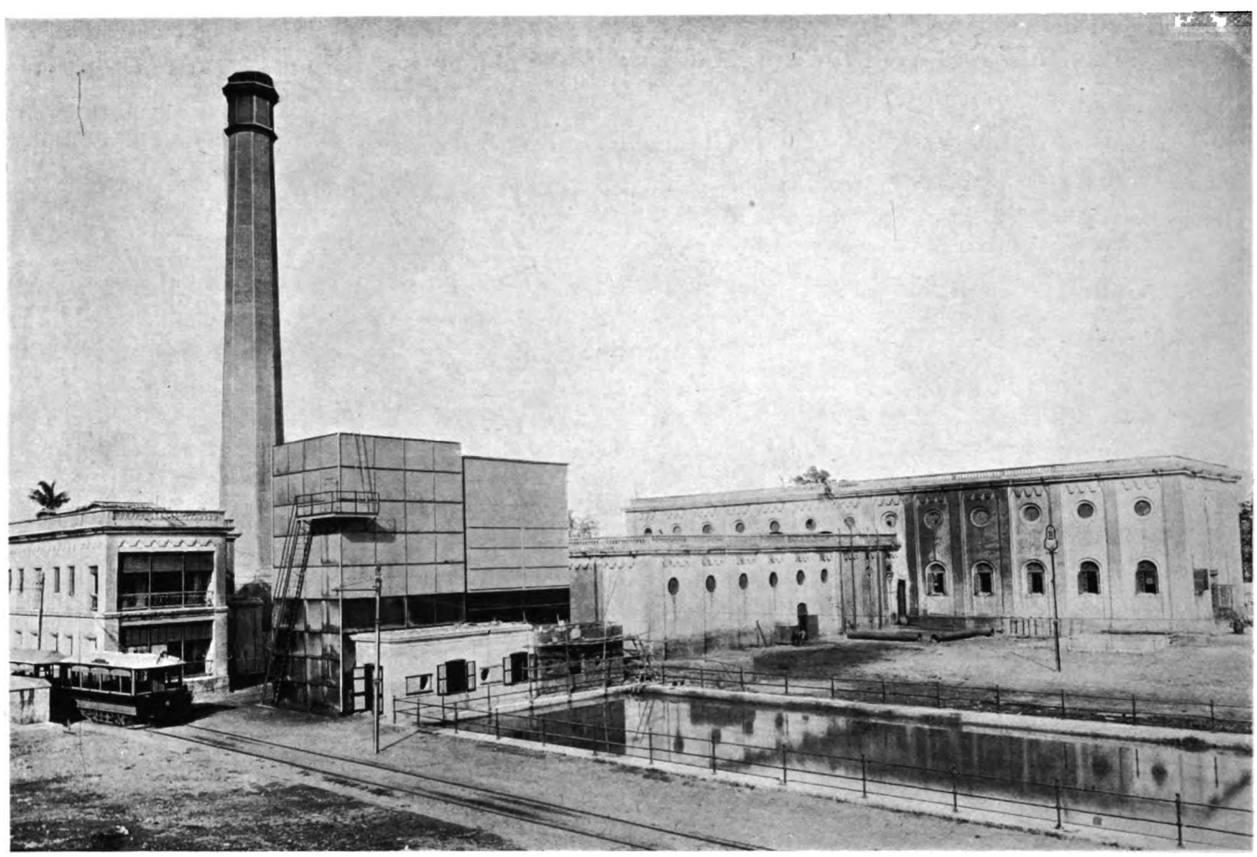
The governor is of the quick-speed type with centre weight and cross arms, designed so as to give the necessary sensitiveness combined with ample power to overcome the resistance of the tripper gear. A sensitive knock-off appliance is fitted to the governor, arranged to disconnect the trippers and hold them in such a position as to prevent steam being admitted to the cylinders in case the engine should attain an excessive speed, or an accident happen to the governing gear. The flywheel is about 16½ ft. diameter, constructed in sections, and weighs about 29 tons.

The smaller engine is of the Robb-Armstrong automatic cut-off manufacture, and of the tandem compound side crank, D.C. type. The I.H.P. is 250, with 135 lb. initial pressure when cutting off at about one-third stroke in the high-pressure cylinder, at 200 revolutions per minute.

Generators.—Each of the three large generators is a standard direct-coupled continuous-current railway generator, as manufactured by Messrs. Dick, Kerr and Company. The normal output of each of these generators is 500 KW., the normal current load-rating being that with a working E.M.F. of 550 volts at the terminals of the machine. Each of these generators can safely carry 25 per cent. overload for an hour without injurious heating. The efficiency of each generator is about 95 per cent. at full load, and about 93¾ per cent. at half-load. The construction is the generally accepted construction of railway generators, as shown in the interior view of the power-house. The generator which is coupled to the smaller engine unit has a capacity of 150 KW., and is direct-coupled to the engine, the general arrangement and mechanical and electrical features of this machine being practically the same as those for the larger units already described.

The switchboard is of the panel type, constructed of enamelled slate, and supported by an iron framework, the whole placed on a gallery at one end of the engine-room. The board consists of four generator panels, one main output panel, ten feeder panels, one lighting panel, one motor panel, three negative booster panels, and one Board of Trade panel. The general arrangement is shown in the general view of the switchboard.

For assisting the rail return distribution, so as to comply with the regulations, which are that no part of the track return should show a greater drop than 7 volts, three boosters have been installed, connected to the track by insulated return cables. These boosters have a respective capacity of 800 amperes at 80 volts, 300 amperes at 120 volts, and 300 amperes at 70 volts.



Nonapukur Power Station.

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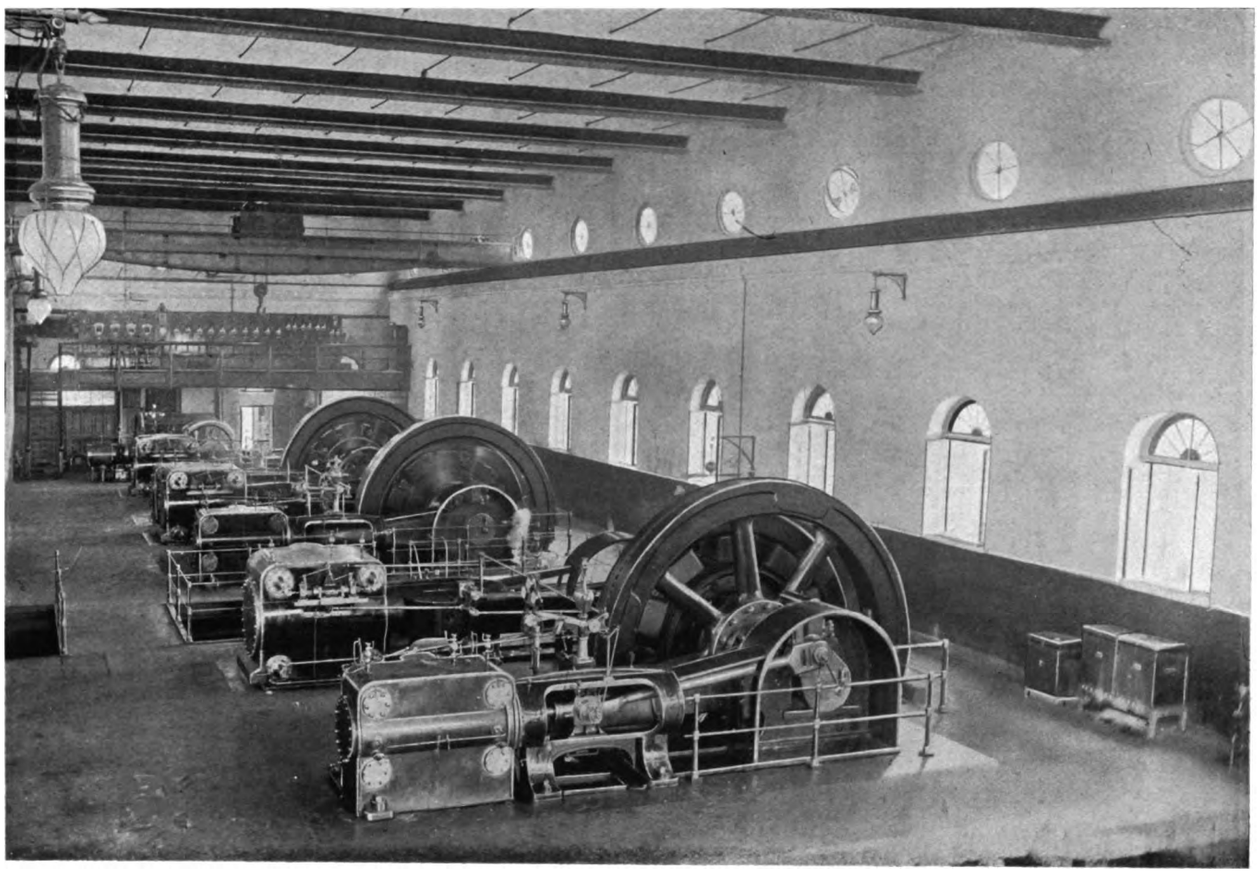
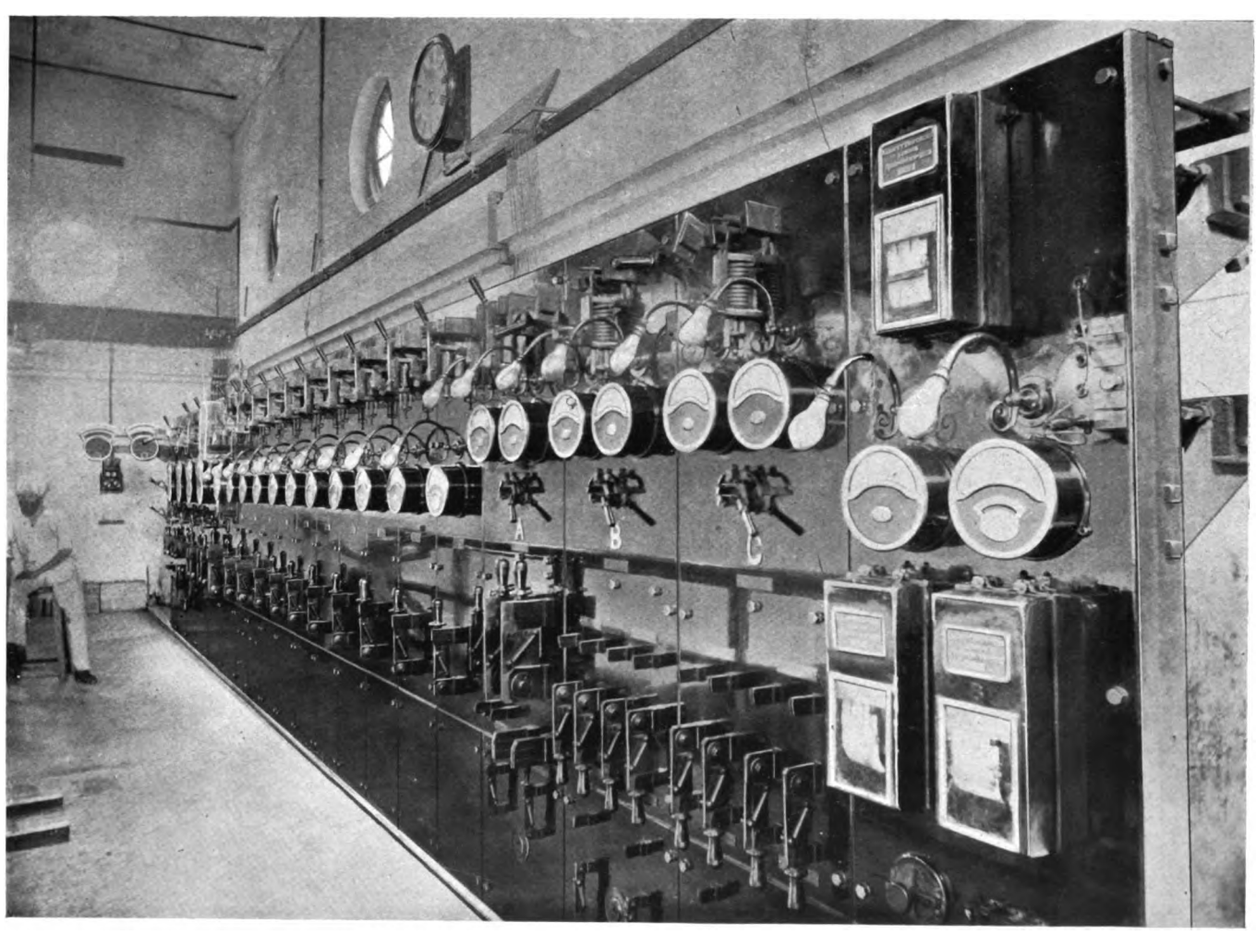


Interior of Nonapukur Power House.



D. C. Switchboard at Nonapukur Power Station.

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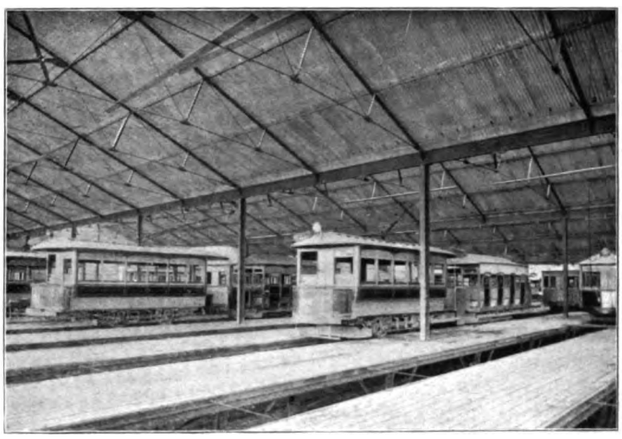
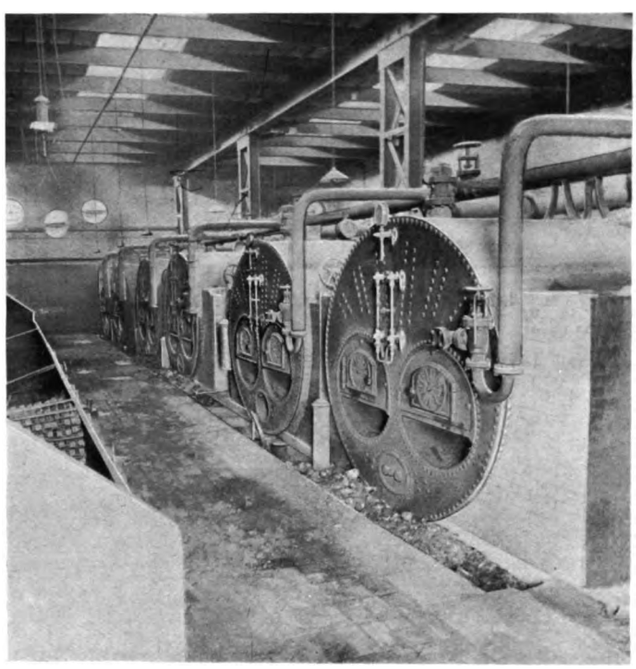


Interior of Nonapukur Car Shed.

The engine room is spanned with the usual overhead crane, designed to lift 15 tons, the manipulation being accomplished by hand.

BOILER ROOM.

The boiler room is shown in the photograph. At present there are 6 boilers in all, of the Galloway (Lancashire) type, 30 ft. long by 8 ft. in diameter. The interior consists of two furnaces joined into one Galloway flue, the furnaces being 3 ft. 3 in. in diameter, solid welded longitudinally and flanged transversely. To the present plant has just been added one Babcock and Wilcox boiler, which will not only help out the present installation, but will form part of the large extensions to the entire plant, as mentioned below.



Boiler Room—Nonapukur Power House.

The three boiler feed pumps are of Weir's patent direct-acting make, each having ample capacity to supply water for four of the boilers, thus leaving one in reserve for the present nominal output of the power-house. The pumps have a stroke of 18 in., and each pump is capable of delivering 30,000 lb. of water per hour.

Ample coal storage is provided by bunkers immediately opposite the boiler fronts, a corner of which can be seen in the view of the boiler house. It is possible to store sufficient coal to operate the plant for four weeks.

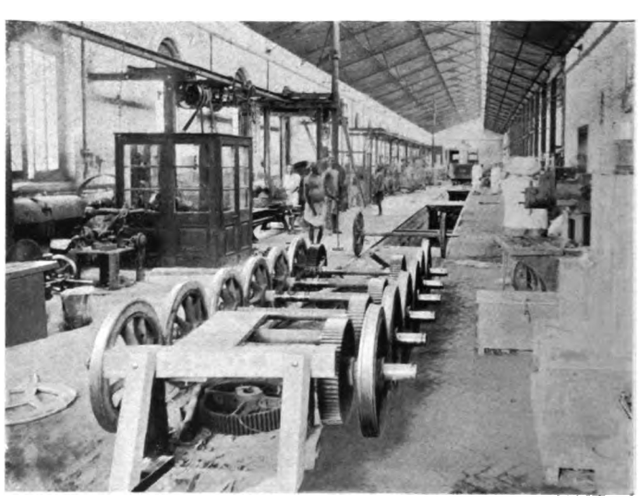
AUXILIARY PLANT.

In connection with the boiler plant a Green's economiser, consisting of 480 tubes, is provided. The condensing plant is located in the basement of the engine-room, and consists of a surface condenser of sufficient capacity to deal with the exhaust from all three main engines, together with two steam-driven air pumps (each having a capacity of two units), and two electrically-driven centrifugal circulating pumps, each pump being capable of discharging 72,000 gallons of water per hour through the condensers and up to the water inlet on the cooling towers. The pumps are mounted on a self-contained bed-plate, with a 35 H.P. motor coupled direct. This plant, in conjunction with the cooling towers mentioned below, is calculated for condensing 36,000 lb. of exhaust steam per hour. When this amount of steam is being condensed, and the pumps are working at full speed, a vacuum of about 21 in. to 22 in. is obtained in the condenser during the cold season when the atmosphere is dry. During the rains, however, the humidity in the atmosphere is great, and in consequence the efficiency of the cooling towers is very much reduced, making it possible to attain a vacuum of only 18 in. to 19 in. with maximum load in the station.

At present there are two cooling towers with fan draught installed for the purpose of cooling the water from the condensers, one being of Klein's patent type, while the other, which was recently installed, is of the Zschocke type. Both are rectangular towers 23 ft. by 20 ft. by 40 ft. high, divided into two sections.

CAR SHEDS AND WORKSHOPS.

Four car sheds located at various extremities of the system have been provided to house the present rolling stock. The principal shed is that at Nonapukur on the



Nonapukur Machine Shop.

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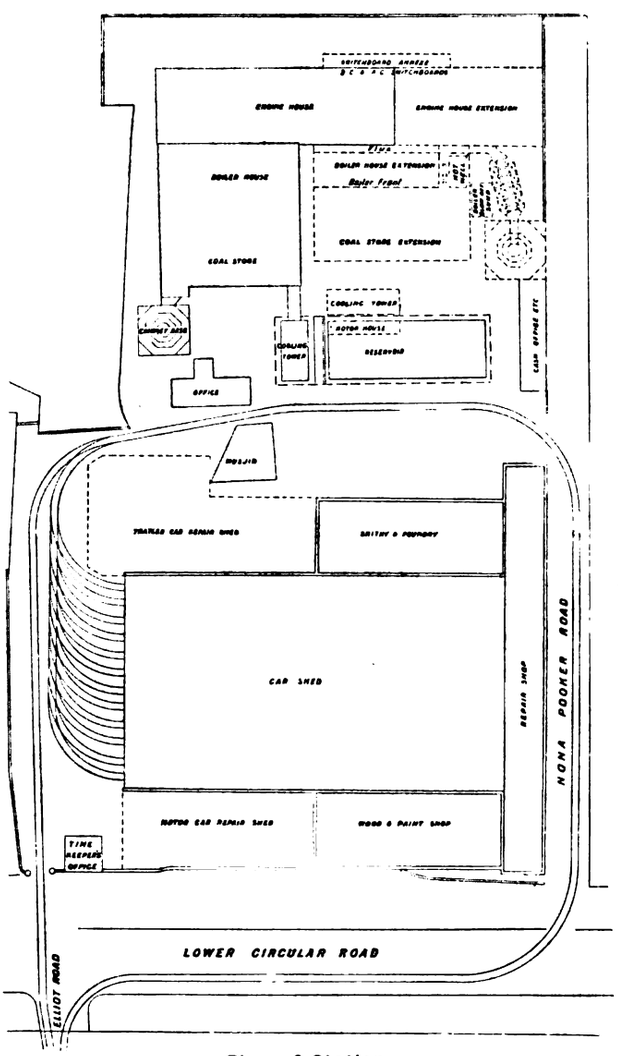
same premises as the power-station. Adjoining the sheds are the workshops, smithy, foundry, paint and wood-working shops, armature winding department, etc., and it is here that all extensive repairs to car-bodies, trucks, and equipments are carried out. The other three sheds attend to small repairs to controllers, lights, and miscellaneous equipments. The Nonapukur car shed and workshop layout are shown in Fig. 3. This likewise indicates the extensions in dotted lines which are now being made to the existing building to accommodate the rolling stock which has been and will be added to the present equipment, due to the increased service which will shortly be run.



Plan of Station.

EXTENSIONS TO SYSTEM.

To provide sufficient power for additional trains which will have to be run to cope with the steadily increasing traffic demands on the existing lines and also for the service on new lines, the power-station is being considerably increased, three-phase alternating-current generators being installed, generating at a pressure of 6,600 volts, the current being transmitted to several rotary convertor sub-stations by means of duplicate three-core cables. These extensions to the plant will form the subject of a future article.

A PLEA FOR INCREASED SPEED.

By H. N. Thomas
(Manager of the Durban Municipal Tramways).

The article appearing in a recent issue of the Tramway and Railway World, entitled "Why the Service is Slow," is of considerable interest, and particularly so when the experience of the effect of such increased speed has already been gained elsewhere. On the Durban (South Africa) Municipal Tramways much higher speeds are run than is allowed on British tramways, and the result is that accidents are quite 75 per cent. less than on tramways in Great Britain.

In the writer's experience of British tramways a very large percentage of the accidents were caused by passengers boarding and leaving cars whilst in motion. Here, due to the much higher speed run, passengers would no more dream of attempting such a feat than they would of boarding or leaving an express train running at full speed; therefore, practically no accidents of this nature occur.

Another cause of frequent accidents in Great Britain is collisions with other vehicles. Here, again, the absence of such accidents I attribute to the higher speeds run. Vehicular traffic is carried on mostly at the proper sides of the roadway, and the tramway track is nearly always clear. A driver of a vehicle knows that if a car comes along he will have to get off the track, and that, although there may not at that particular moment be any in the vicinity, they travel at such a speed that it will not be long before one is upon him. Consequently, for sheer laziness' sake, he will not go on the track any more than he can possibly help. True, the roads here are much wider than in Great Britain, but, for all that, there is the fact that the vehicular traffic could and would be carried on clear of the track if higher speeds were allowed, and I maintain that the increased speeds will lead to greater security to the public for the reasons stated. The streets in and about the centre of Durban have just as much traffic on them as the majority of British provincial towns, and they have the further disadvantage of a much—very much—less intelligent class of men driving a large number of the vehicles (the raw Kaffir being much in evidence), and yet, in spite of this disadvantage and the higher speeds also, the accidents due to this cause are practically *nil*.

A feature of the question that will appeal to the British tramway man is the decreased wear and tear that would ensue through the absence of vehicular traffic over the tramway track.

Unprofitable Motor Omnibuses.—At a meeting of the Eastbourne Town Council on the 5th inst., it was reported that the motor 'bus accounts for the past year showed a loss, allowing for depreciation, of about £1,000. As a remedy it was decided to strike off the non-paying routes and decrease the winter service. It was also proposed to discard the single-decked 'buses and to convert them into water vans and dust carts. The loss was mainly attributed to the single-decked 'buses.

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LONDON, JUNE 8, 1905.

L. C. C. Tramway Schemes.

The London County Council have now sanctioned the going forward with the most gigantic tramway scheme which this country has seen, and indeed it can only be rivalled by such great undertakings as those in New York and Chicago. The Council have confirmed the proposal to acquire from the North Metropolitan Tramways Company their remaining interest in the lease of the North London lines, and to proceed as soon as possible to convert them all to the electric system, and to build additional lines, at a cost which is put in round figures at five millions sterling. The total length to be dealt with is 108 miles measured at single track, which represents somewhere near 60 miles of route. Estimates show that if the Council are allowed to construct half of the routes on the trolley system the cost will be about £470,000 less than if the whole is built on the conduit method. This means that on the North London undertaking alone the conduit system throughout will cost about a million more than the overhead system. As the interest and sinking fund charges on a million amount to about £70,000 per annum, the difference is very important and may mean all the difference between the tramways working at a substantial profit and working at a loss. The estimates of revenue and expenditure show that if the conduit system is adopted throughout there will be just about enough spare revenue to pay interest and sinking fund, and provide a reserve of 1½d. per car mile for renewals. The latter reserve is, of course, considerable, and may never be all required.

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We confess to a feeling of some mistrust about the financial success of this great scheme. While it is true that the Council pay high wages to their employees, it is not so much the question of everyday working expenses which troubles us. In the estimates these are put at 7d. per car mile, apart from the reserve for renewals, and as the Southern tramways are now working at 7½d. per car mile with purchased energy costing at least double the price at which it will be produced at the Council's station at Greenwich, we see no reason to doubt that the figure of 7d. will be realised (unless the Council increase wages still further). Similarly, there is no reason why the estimated revenue of 1s. per car mile should not be realised unless ruinous reductions are made in the fares. The trouble does not lie there. It lies in the enormous capital expenditure. Doubtless tramway construction and equipment must be dearer in London than in other towns owing to high wages and the enormous cost of land. But this does not appear to be a sufficient reason why capital expenditure should not be kept down. These estimates for North London run up to about £44,000 per mile of single track, allowing for half of the track being on the trolley system. If we exclude the cost of street widenings (nearly a million), and of the second portion of the generating station, we still have a figure of about £27,000 per mile of single track for construction, equipment, sub-stations, and rolling stock. About £4,000 of this represents the money to be paid to the tramway company for horses, cars, and consideration for abandoning the lease. The figure is still very high, and it behoves the Council to do everything in their power to keep down the capital expenditure.

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The construction of about 17 miles of track recently authorised in South London, just

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decided upon, promises to work out (excluding any proportions of street widenings and of generating station) at about £20,000 per single track mile. Fewer cars per mile will be needed on these routes, so that the price is less. A loss in working is, however, predicted at first, till the traffic develops and the interest charges drop. The Council's Finance Committee look forward to a total tramway capital expenditure of between eleven and twelve millions, including the purchase price of horse lines. If the Council will persist in refusing to allow private enterprise to come in and help in the gigantic task and to take some of the risks, a most careful policy will be required for years to prevent heavy losses. There is at all events one feature which is exceptionally favourable to the Council's enterprise. The Council do not own, and probably never will own, any lines outside the county of London boundary. Hence a great and increasing percentage of the lines are on routes of heavy traffic. There are comparatively few lean lines, and as time goes on even these will quickly fatten. Thus the Council have some chance of meeting the great capital expenditure.

London Southern Tramways.

In reference to the suggestion that the London County Council would show wisdom in co-operating with private enterprise in meeting the vast tramway needs of the metropolis, a decision given in the end of May by a Committee of the House of Commons is of interest. They had before them a bill promoted by the London Southern Tramways Company for the conversion to electric traction of the lines of that Company, some 5½ miles in length, and for extending the period before the County Council can buy the system to 42 years. Strange to say, the Committee, without allowing the promoters to present a large part of their evidence, threw out the bill—a course which, as was pointed out by counsel, is contrary to all Parliamentary practice. It certainly seems an extraordinary thing that the promoters of a bill should not be allowed to present their case for it; a repetition of such action will shake public confidence in Parliamentary Committees on private bills.

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The point, however, which we wish to bring out is a different one, and depends on history. Some two years ago the County Council considered whether they would buy the undertaking of the Company under the Tramways Act, and it was proposed that, as the lines did not promise to be remunerative (after reconstruction on County Council scale of expenditure), they should not be bought. This proposal was revised, and it was agreed to purchase, provided the Lambeth Borough Council (in whose area a good deal of the tramways lie) would contribute £40,000 to the cost of street widenings in connection with doubling some single track. The Borough Council refused to offer more than £20,000, and in the beginning of last year the County Council decided not to buy. That being so, the Company promoted the bill which has just been killed, and they obtained the assent of both the Borough Councils concerned, those of Lambeth and Camberwell. In the course of evidence before the Committee it transpired that Lambeth had now agreed to increase its offer to £25,000 if the bill was not passed, and that the County Council would then buy the system. The County Council were the only opponents to the principle of the bill. Thus it will be seen that the County Council have again definitely refused the aid of private enterprise, even in the case of a line which they think they could not work at a profit, but which a company was prepared to take the risk of working. Another matter is that some six years will elapse before the County Council will have another opportunity of buying on Tramways Act terms.

A Practical Comparison between Steam and Electric Locomotives.

It would indeed be difficult in this small country to find a four-track length of six miles on which two of the lines, running in the same direction, could be kept clear of traffic for five hours during daylight and on a week-day in order to carry out experiments of any kind. This was, however, done in America at Schenectady on a so-called "experimental" track, forming part of the old track of the New York Central main line (formerly used for east-bound goods trains), from mile 162 to mile 168 west of Schenectady, between 8 a.m. and 1 p.m. on Saturday, April 29 last, in order to test the comparative accelerating qualities of steam and electric locomotives. Needless to say the steam engine was beaten hollow. Six runs were made on an 80 lb. steel track, with 36 in. 6-bolt fish-plates, and with

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16 yellow-pine sleepers to the 30 ft. rail, this being about 33 per cent. more in number than is usual in England. The ballast was gravel, but the photographs published show that the sleepers were not boxed in at all; so that it is not surprising that, although the line was super-elevated for a speed of 70 miles per hour, the rails shifted on the ballast at speeds of over 80 miles per hour; this shifting was put down to insufficient super-elevation on the curves, the sharpest of which was one of 20 deg. 17 min. for a length of 1,298 ft. The line rises from mile 162 for about 4½ miles, and then falls to mile 168. Five of the trial runs were made from the former mile post, the sixth and most instructive from mile 164; from this point to the terminus the gradients vary from 1 in 770 to 1 in 312 up, and from 1 in 833 to 1 in 286 down, the curves being from about 1 deg. to that mentioned above; there was no stretch of level, and about one-third of the distance was on curves. The experiments were carried "under the auspices" of the General Electric Company and of the New York Central and Hudson River Railroad, to obtain data regarding the performances and capabilities of the electric engines they are introducing on underground lines, as compared with those of their present steam locomotives. The fifth or "D" experiment approached nearest to the conditions under which the new locomotives will work, and was, therefore, as has already been noted, the most instructive. The engines were respectively 36 ft. 11¼ in. (electric), and 67 ft. 7¾ in. (steam), in length; the first weighed just over 89½ tons, the latter, with tender, 102 tons 13 cwts. 2 qrs. 8 lb. The concentrated weights on each driving axle were, respectively, 15 tons 17 cwts., and about 21 tons, while that on the eight driving wheels of the first was only 1,000 lb. over that on the six driving wheels of the second. The weight of the trains behind the engines was 307½ tons (electric), and 256 tons (steam), while the acceleration in miles per hour per second, averaging up to 50 M.P.H., was ·394 and ·246 respectively; the seconds required to reach that speed being 127 and 203; so that 1,500 feet from the starting point the electric train was its own length clear of its rival. By reason of the restricted cross section of the conductors the voltage, during acceleration, dropped considerably below that which will obtain in actual practice when, under more favourable circumstances as regards the electric engine, the comparison with the steam locomotive will show to the still greater advantage of the former. The weather was fair, the rails were clean and dry, and the electric engine ran most smoothly and without any "nosing" or pitching. These results must be most encouraging to the railways in this country which are introducing many electric locomotives for the purpose of running their own goods trains and trains of all kinds belonging to "steam" lines, and having running powers over the electrically-equipped railways.

The Electric Tramway and Railway Exhibition.

The Electric Tramway and Railway Exhibition which will be opened on July 3, promises to be a satisfactory exponent of the progress that has been made in electric traction during the last three years. When the first exhibition was held in 1900, the extended use of electricity on lines both surface and underground, was looked upon more or less as the dream of a few enthusiasts; the dream has come true to a marvellous extent in the interval, and the approaching exhibition will give the public who are not quite "in the know" an opportunity of judging for themselves how these dreams have materialised. There, also, will come together men who are experts in tramway working, not only from all parts of the British Isles, but from abroad and from over the seas West and East. They will find that although it has not been possible to find room for such big exhibits, the variety is greater than it was at the two previous exhibitions; for as electric roads have grown in size, in power, in importance, so have their requirements increased not only in magnitude but in variety, irrespective of the improvement to old and the invention of new appliances. Referring to Garcke's Manual, for instance, we find that in 1902, Section III., "Manufacturing and Miscellaneous," took up 154 pages, while in 1905 the same section occupied 218 pages, an increase of over 40 per cent. This is only natural when it is considered that the track mileage of electrical railways (excluding tramways) in operation, under conversion, and authorised in London alone has risen from 117 miles in 1902 to nearly 300 in the present year, and this in spite of the Royal Commission on London Traffic,

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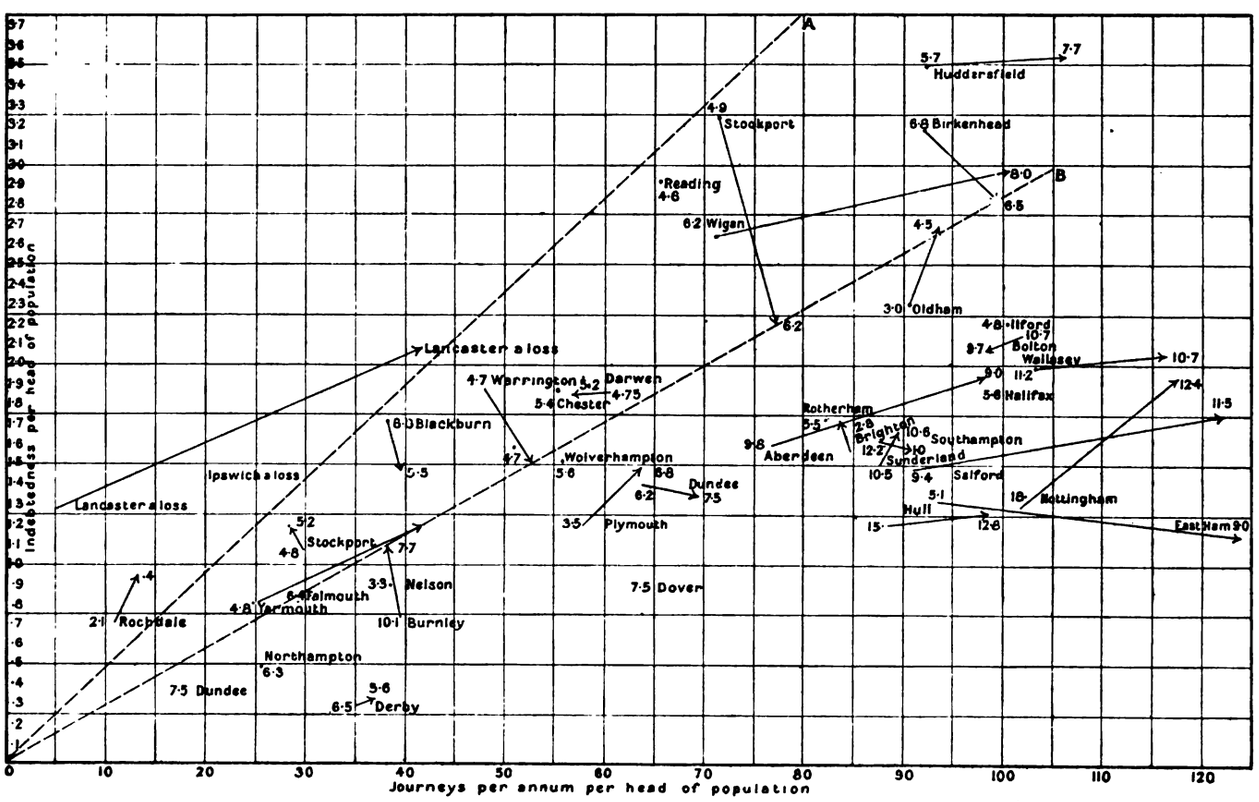
TRAMWAY PROFITS AND RELIEF OF RATES.

It is a reasonable contention that municipal tramways should be organised and managed on a system which will admit of a profit being made for a reduction of the rates, over and above the cost of working. With the best intentions in the world, it is scarcely to be expected that all municipal tramway ventures should afford the same benefit to the rates. A certain sum of money is expended in providing a tram service; its financial success must depend upon the extent to which it is used. It may turn out that the service is not utilised to anything like the extent anticipated, and thus the city is burdened with an unprofitable undertaking that no amount of good management can render remunerative. It is useless, however, deploring past mistakes, and there is, indeed, room for congratulation that in England, at least, they have been so few. With regard to present working, the question remains whether it is a fact that part of the profit legitimately earned is distributed in a reduction of fares instead of in a reduction of rates, as should be the case. This is, of course, an extremely difficult question to answer, and it is impossible to expect anything in the nature of a rigid or absolute proof. A statistical examination, however, throws considerable light on the matter. The capital debt of the undertaking (less sinking funds applied and on hand) may, for the purpose of comparison, be conveniently expressed in pounds sterling per head of population. A certain number of journeys per head of population per annum must then be made before the undertaking can become profitable. If it is found that the latter quantity stands in a certain ratio to the former, and wherever, throughout the country, this ratio is exceeded, a *proportionate* profit is made in money, *i.e.*, available for reduction of rates; then there will be very good grounds for believing that dissatisfied ratepayers of the opinion expressed above have little ground for their suspicions. That this hypothesis corresponds very closely with actual fact the accompanying diagram demonstrates. The ordinates measure for each city named the present indebtedness of the tramway per head of population on the scale of 10s. to the inch. The abscissæ measure the number of journeys per head of population on the scale of 10 journeys to one inch. The figures placed against the towns named show the percentage of net income to the indebtedness.

It will be seen at once that all those towns placed to the left of the line O A do but poorly, while those to the right of the line O B are prospering, and in passing from one to the other there is a steady increase in the amount of nett income. It is true there are notable exceptions. Derby furnishes one; but Derby has horse tramways, and should not rightly be included. Nelson is another; but here the conditions are exceptional. Oldham and Birkenhead ought, apparently, to change places. Nelson and Reading should do the same. But for the most part the law is clear that when the utility of the concern more than justifies the indebtedness, a proportionate sum is generally available for the reduction of rates.



Large towns like Manchester, Cardiff, etc., which cannot be got into the chart, are even better illustrations of the law.

In most cases it has been feasible to show the position for the previous year as well as for the last year for which the accounts are published. In these cases the positions are joined by a straight line, the direction of the arrow-head indicating which end refers to the earlier and which to the later year. The figures giving the per cent. of nett income to indebtedness for either year are placed at the end of the line to which they belong. It will be seen that the changes in profit are for the most part such as might be expected from the alteration of position, and where this is not the case, as with Plymouth and Oldham, an average of the profit in the two years usually shows a better conformity to the law, thus suggesting that the profit obtained in one of the years was anomalous.

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THE ELECTRIFICATION OF MAIN LINES OF RAILWAY.

By W. E. Langdon,

Past President Inst. E. Engineers; Late Supt. Electrical Department, Midland Railway.

The step which has recently been taken by the New York and Hudson Bay Railway Company in the determination arrived at to work the *entire* traffic for a distance of some 40 miles into and out of New York by electrical locomotives, is by far the most important advancement which has yet been made towards the accomplishment of the general electrification of railways.

Free from many of those impediments which —in the interest of one class at the cost of another—embarrass our own productions, industrial enterprise moves in America with an energy and dispatch which it would seem impossible for others, less free, to emulate. In the fall of 1900 the author read before the members of the Institution of Electrical Engineers a paper, "On the supersession of the Steam by the Electric Locomotive," which at the time attracted considerable attention. Its object was to show the advantages and economies that would attend the conversion whenever it should take place. Although the author did not himself contemplate any immediate step on the part of the railways in the direction of the title of the paper, but, on the contrary, rather pointed out certain difficulties which stood in the way, it gave rise to the impression that the days of the steam locomotive were numbered.

Yet, here we are, in the year 1905, very little nearer the mark. Four years have passed, but so far as the conversion of any portion of our main lines is concerned, we—in England—are unable to point to any material advance. True, we can claim to have established the pioneer electric railway, and we have, to some slight extent, supplemented steam traction on certain suburban sections of some of our railway lines, the neighbourhood of which has been invaded by the electric tramway; but all that has been done —the electrification of the Lancashire and Yorkshire Company's Southport line, and the North Eastern Company's Tyne branches not excepted —leaves us still with the general question unsolved.

What has been done, and much, if not all of that which, it is understood, is in contemplation, has for its purpose the production of a certain class of traffic. Its object has not been conversion, pure and simple, but merely to stem an adverse tide affecting a certain locality. It is only where conversion, entire and complete, takes place—where the entire traffic is operated by the one source of power—that we may look for a satisfactory issue of this great and important question.

In the conversion of the Metropolitan we have something which we may accept as fairly analogous to our main lines. Not quite so, for although during a great portion of the 24 hours the traffic is such as to afford a constant and evenly distributed load, the line is not in operation, as are the trunk lines of our railway system—throughout the 24 hours. Still, it will be a fair criterion of what may be anticipated, especially where the electrical system is formed upon more economical lines. As such its outcome will be watched with more than general interest.

It is understood that the locomotives which have been ordered by the City of New York Railway Company are to be capable of hauling trains of 450 tons at a speed of not less than 60 miles an hour; and that, where the load exceeds 450 tons, provision is to be made for coupling two together, and operating the two from either, on the multiple unit system. The power would, therefore, appear to be ample to meet the demands of any of our own lines.

This decision on the part of our American friends, although in a large measure forced upon them by the disadvantages which attend the construction of the line on its approach to the city of New York terminus, is undoubtedly destined to exercise a most important and far-reaching influence in the supersession of the steam locomotive. It is the main step, and will remove much that has appeared to be hitherto impossible; for, however well inclined railway companies may feel towards the adoption of electrical power, until it is quite clear that a convenient and reliable substitute for the present hauling machine is obtainable, there is little prospect of the proposition being considered.

In the conversion of our main lines we have to look at the subject from a very different standpoint than that from which what has hitherto been accomplished has been viewed. It is a *sine qua non* that the change shall entail, so far as the traffic arrangements are affected, simply a change in the hauling machine. Whenever the transference is undertaken it is bound to be dealt with in sections. Over those sections the traffic must be conducted—at all events for the time being—precisely as before, and subject to the conditions which attended it in the adjoining section, the only difference being that the moving power is electrical instead of steam.

Subject to such conditions the railway company's outlay becomes, practically, limited to the generating plant and the distribution service. The cost for electric locomotives would take the place of that for steam locomotives year by year as they fall in for renewal. In the rolling stock—whether passenger or goods—no change need be contemplated, for, however suitable the form of passenger car which has come into

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vogue on the, so far, electrified lines; or those which it is in contemplation to use on the Metropolitan, may be for short journey trains, it is questionable if it would, in construction, comfort, or privacy, meet the demands of long journey traffic.

It is, perhaps, premature to consider—even now that we have something tangible to look at—the economies that may be looked for, for much depends upon the electrical system that may be adopted, and in this much depends upon the Board of Trade. It is probable, however, that whatever system is used it would not be more costly than that under which the Metropolitan is to be worked, and, consequently, should the anticipated economies attending the electrification of that line be attained, we may look for still greater advantages in its adoption by our main lines.

The electrification of the Lancashire and Yorkshire Company's Southport branch, as also that of the North Eastern Company's Tyne branches, has been referred to by the chairmen of the respective companies as satisfactory—as being productive of an increase in the number of passengers. Details, however, are not forthcoming. Whatever those figures may be we do not regard these experiments as a criterion by which to gauge the cost of complete and comprehensive works. We are inspired to say this because we fear there may exist, in some quarters, a desire to view them in a more conclusive character than a due consideration of the conditions which attend their application justify.

The step taken by the City of New York Railway has not for its primary object, economy. The economies which will follow the adoption of electricity can easily be determined, given the fundamental factors, viz., the power to deal with the traffic as it is now dealt with; the electrical system to be employed; and the mode of distribution. The action of the City of New York Railway will determine the first point, which, to the railway mind, will prove by far the most important.

THE ROYAL COMMISSION ON LONDON TRAFFIC.

Evidence Concluded.

The Royal Commission on London Traffic held sittings in private on May 4 and 5, at the Westminster Palace Hotel, London. They have practically concluded the consideration of their draft report, and these sittings were held for the purpose mainly of taking some further evidence. The witnesses on the first day were Mr. Daniel Duff, manager of the London Road Car Company, on behalf of omnibus proprietors in London; Mr. A. T. Salisbury Jones, chairman of the London Motor Omnibus Company, Limited, and Mr. A. Campbell Swinton, Member of the Institute of Civil Engineers, chairman of the London and District Motor 'Bus Company. Their evidence was chiefly directed to the results that have attended the introduction of motor omnibuses into the streets of the metropolis in respect of traffic, cost of operation, renewals, repairs, and depreciation. On the second day the witnesses were Mr. C. R. Bellamy, general manager of the Liverpool Corporation tramways, and Mr. J. M. EcElroy, general manager of the Manchester Corporation tramways, who attended to supply the Commission with details of tramway working in these cities.

THE BARCELONA TRAMWAY COMPANY, LIMITED.

A Prosperous Undertaking.

The pruning received by Spain at the hands of the United States on the termination of the last war, when her principal colonies were cut off, seems to have turned out as beneficial as her most optimistic well-wishers could have expected. Her recuperation, though somewhat obscured by political turbidity, proceeds apace, and is particularly well marked in the chief commercial town, Barcelona. The extent of the general improvement there may be to some extent gauged by the traffic returns of the tramways of that city. Thus the Barcelona Tramways Company, Limited, an English incorporation, received £103,680 for the year ending December 31, 1904, against £88,298 for the year before, an advance of 17½ per cent.

This is certainly a remarkable achievement for a tramway undertaking registered in 1872 and electrified throughout in 1900, unaccompanied, as it has been, by any further expenditure on capital account or increase of mileage operated. At the date of the ordinary general meeting of the company in April last the increases of the traffic returns for this year had already amounted to £4,600, of which the chairman considered that £4,000 at least would be net profit, and since that date the increases for the year have improved to £6,000, while the exchange with Barcelona is lower, so that the prospects for the present year are exceptionally good.

The company also received £3,940 from the Barcelona, Ensanche y Gracia, a subordinate company of which the Barcelona Tramways Company, Limited, holds all the shares and debentures. The traffic returns of this smaller company have not now the same immediate importance to shareholders as was formerly the case. Until recently its earnings did not suffice to cover the debenture interest, so that any changes directly affected the revenue account of the owning company. Now its earnings more than cover the debenture interest, and the surplus is applied to redemption thereof, so it will furnish a fixed contribution to revenue approximately the same as last year.

The items of expenditure are low for the amount of work done. The trolley system is used. There are 2½ miles of single track, 9 miles double, 140 cars (mostly single decked), seating capacity 44.

Expenses.

	£	Pence per Mile Run.
Generating station:		
Coal	8,049	·57
Wages, etc.	2,816	·20
	£10,865	·77
Traffic expenses:		
Wages and salaries	23,681	1·68
Uniforms	1,051	·07
Etc.	2,110	·15
	£26,842	1·90
Maintenance:		
Way and works	1,330	·10
Rolling stock	4,198	·30
Machinery, etc.	3,519	·25
	£9,047	·65
General charges	7,141	·51
Taxes, etc.	5,324	·37
	£12,465	·88
Total working expenses	59,219	4·20

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Adding £16,600 for the service of debentures and £5,000 for interest on preference shares, we obtain £80,819 as the normal expenditure for the year.

The total receipts, including that from the Barcelona, Ensanche y Gracia, and a few unimportant sundries, amounted to £107,784. There remained therefore some £18,965, which, distributed among 20,000 ordinary shares of £10 each, on the supposition that sinking fund for the debentures afford a sufficient provision for depreciation, would have provided a dividend of nearly 19s. per share.

The accounts, however, for last year, include an item of £3,834 in the nature of a betterment outlay, as has been since explained, but charged there to special expenditure and renewals, also the directors thought fit to add £10,000 to the renewal fund, and these appropriations, together with some minor items which need not now detain us, as they are not likely to recur, reduced the dividend for the year 1904 to 12s. per share, free of income tax.

Passing now to the capital account, the principal features are: 10,000 cumulative preference shares (5%) of £10 each, and 20,000 ordinary shares also of £10 each, making £300,000. Then there are two issues of debentures amounting in all to £237,626, a sinking fund of £11,103, a renewal fund of £17,000, and other liabilities amounting to £14,297.

On the other side the undertaking stands at £454,648, other assets at £129,176, cash £9,501, and creditors £1,227. It will be seen therefore that the capital account is considerably over spent.

The undertaking, standing as it does at a figure which works out at over £22,000 per mile of single track, must be regarded as including one-third for the value of the concessions.

The financial position of the company is, however, progressing in the right direction. Comparing the last balance sheet with that for the year 1902, the debentures outstanding are £11,074 less, the debenture sinking funds amount to £9,785 more, the renewal fund is £12,000 better, a fictitious debit of £935 has gone. Creditors are £2,451 less, debenture interest accrued and dividends unclaimed are £699 more, and the balance is £1,969 higher.

On the other side the tramway stands for £10,291 more, the Barcelona, Ensanche y Gracia for £959 more, the Compañia Nacional for £159 more. Spanish taxes in suspense to the amount of £316 have disappeared (given up, in fact, as hopeless), stores are £1,947 more, horses and mules (a new account) £303; debtors are £1,507 less, and cash £1,839 less, so that money no doubt was borrowed to pay the dividend.

The general effect of the changes during the two years may be summarised by saying that £11,000 of debentures have been paid off, and £12,000 have been spent on improving the assets.

The concessions under which the company is working are numerous, and date from a time when only horse traction was in contemplation. Consequently, they are extremely vague as to what shall happen when they determine, as they will at various dates from 26 to 40 years hence. The presumption is that the company will then cease to have any monopoly in the use of its track, but will retain its property in the plant and rolling stock, etc. Taking these with the other assets at half their present value, and deducting current liabilities, we have, say, £160,000.

A sinking fund for the debentures is already established; there would consequently remain £140,000 of share capital to redeem, involving, at 4 per cent., an annual charge of £2,500. During the last three years an average of £5,660 has been appropriated for a renewal fund in addition to the recent expenditure on special expenditure and renewals. The future is, therefore, by way of being well provided for.

Although the present prosperity of the company is no doubt fundamentally due to the prosperity of the city of Barcelona, this does not account for its sudden appearance. For the year 1903 only 3 per cent. was paid on the ordinary shares, and but £2,000 placed to the renewal fund, while to do even this the carry-over had to be encroached upon. During the 12 months ending March 31, 1905, however, the traffic receipts increased £20,000 or more, an expansion of over 22 per cent.

We do not know the number of miles run during that particular 12 months, but 3,278,883 are recorded for the year 1903, and 3,362,716 for the year 1904, so we shall not be far wrong in assuming that the increase of miles run in the period did not exceed 100,000, which goes a very short way towards explaining the greater traffic receipts. This period, indeed, dates from the introduction of certain changes into the local management, and for the results to have been as good as they have turned out, the management must have been exceedingly lax in the past. Proceeding now to a consideration of the immediate prospects, the chairman's speech on the occasion of the last ordinary general meeting of the company will be found unusually illuminating. The increase of the traffic receipts had at that date already amounted to £4,600, of which £4,000 were pronounced net profit. £5,000 is to be spent this year on special renewals and, an as yet undecided sum, as a special reward to the managing director; on the other hand, £600 will be saved by a reduction of taxes: and the traffic returns showing already a further increase of £1,500, which at the same working ratio, 58 per cent., would provide another £600, the earnings for the current year are not likely to fall behind those of 1904, which by the above computation amount to £107,789, less £59,219, that is to say, £48,565.

From this deduct, as before, £16,600 for the service of debentures, £5,000 for interest on preference shares, and allow £6,000 as addition to the renewal fund. There remains then £20,965 available for dividend on the ordinary shares. Of this £12,000 is required to pay 6 per cent., the directors are entitled to 5 per cent. of the remainder, *i.e.*, £450, by way of extra remuneration, leaving sufficient to pay another 4 per cent. to the ordinary shareholders, if the carry-over is kept as before.

No allowance has here been made for alterations in the exchange.

The average for last year was 34.70 Ps. per £, whereas the rate now current is 33.30. The exigencies of the business must require an annual remission from Spain of nearly Ps. 2,000,000, so that a fall of one in the average rate of exchange for this year would effect a saving of about £2,500, or sufficient to pay 1¼ per cent. on the ordinary share capital. It is too early in the year to vaticinate on this, but in considering the immediate prospects of the company the average of exchange must not be left out of sight.

The share list in June, 1904, showed the shares to be well held and widely distributed. The present directors held 450 preference shares, and 441 ordinary shares between them, and a block of some 2,600 shares in all, held under three names at one address in Austin Friars, indicates the source of financial support.

What the transfers were during the subsequent 12 months we cannot say, as the return was not filed with the Registrar of Joint Stock Companies on May 20 last when our examination was made. The information would be useful since the shares were quoted very low at the beginning of the period in question, which was the time when the changes in administration, already alluded to, were introduced. From the foregoing it will be seen that the company

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after making a sufficient provision to secure its assets, is able to pay 10 per cent. on its ordinary share capital. This is a result which very many tramway undertakings in other parts of the world would only be too happy to be able to show.

Estimating on a 5½ per cent. basis and allowing for amortisation of the premium, these shares are found to be worth £17. They have, indeed, during former years been quoted at figures the average of which brought the yield from the dividends paid to less than 5 per cent., but in these prices no doubt the future was somewhat discounted. The chief danger is that the board of directors may fall into the common error of making relatively unremunerative extensions.

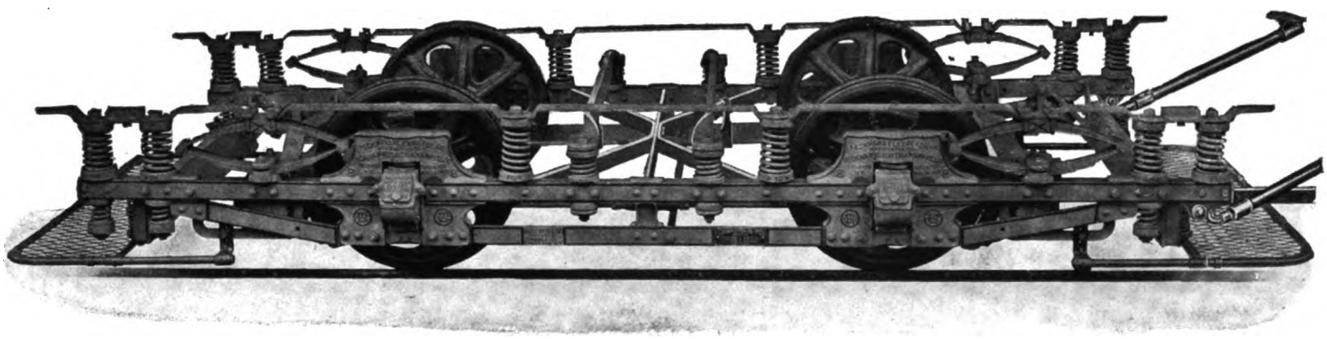
The present price is £13. The future offers further potentialities of appreciation, in that the population of Barcelona, including the contiguous suburbs, already exceeds half a million, and is increasing at the rate of some 10,000 per annum, so that as far as can be guessed by analogy the average normal increment in the weekly traffic returns should amount to £50.

The cumulative preference shares of £10 each are of course well secured, and cheap at the present quotation of 10½, but as the holders have no claim to more than the par value in the event of a winding up, there is little room for appreciation in price. The debentures, repayable, the 5 per cent. at 110, and the 4½ per cent. at 105, are unquoted. They date from an unprosperous time in the history of the company.

A company whose receipts per mile of single track exceed £5,000 per annum deserves to be better known in the country of its incorporation, where, save in the cases of London and Glasgow, so high an average density of traffic is nowhere attained.

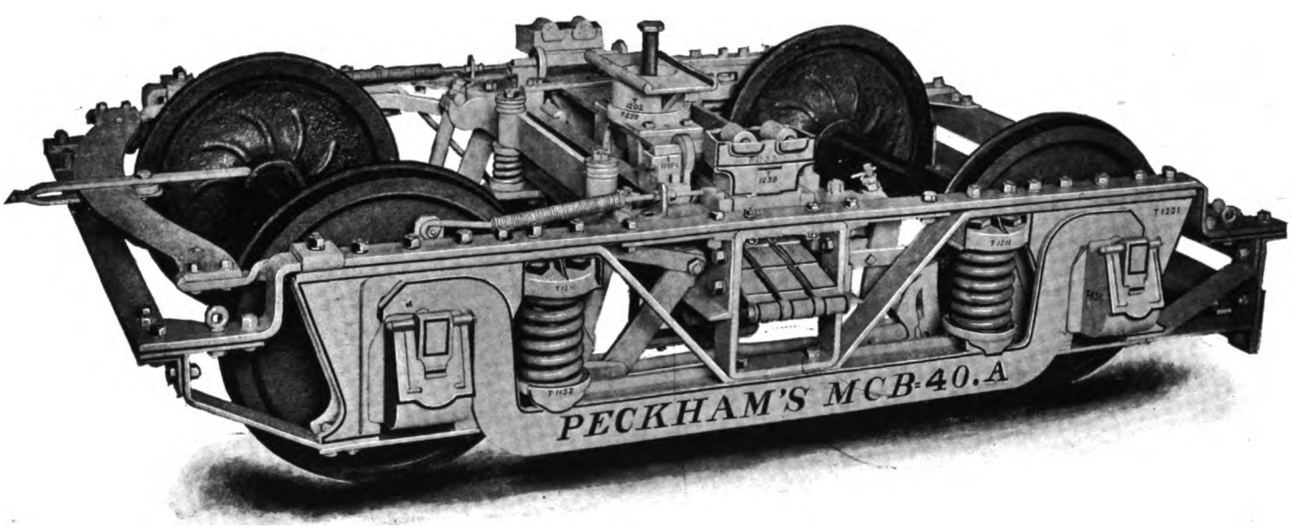
IMPROVEMENTS IN PECKHAM TRUCKS.

Mr. Edgar Peckham, president of the Peckham Manufacturing Company, of Kingston, New York, and the inventor of the Peckham cantilever trucks, of which some two thousand are in use in Dublin, Manchester, Leeds, Halifax, Bradford, Bournemouth, Sheffield, Birmingham, Croydon, Barking, and other large electric tramway systems in this country, has been spending several months in England investigating the conditions of the service required of electric trucks in this country. On account of the universal use of double-deck cars, the conditions differ widely from those in America where no double-deck cars are used, and they require special consideration from the designer.



Peckham Extra Long Cantilever Single Truck.

As the result of his investigations, Mr. Peckham has improved the construction of his cantilever truck by means of which (as he claims) it will carry successfully eighteen and twenty foot double-deck cars without increasing its wheel-base.



Peckham High-Speed Truck.

The improvements made may be enumerated as follows:

1. In the construction of the side frames which have duplex steel bars in one piece, doing away with the cast (malleable iron) pedestals, and the bolts and rivets used to secure them to the truck side bars.

2. In the design and construction of a new "pendulum gear" for supporting the side frames upon the journal boxes. The construction of this gear is such that the side frames of the truck are so suspended from the journal boxes that the axles can move laterally, and relieve the wheel flanges from side pressure when rounding curves or upon an uneven track.

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3. In the re-arrangement of the car body supporting springs, by which the spring-base of the truck is increased without increasing the wheel-base. In place of the spiral end springs used in the old construction are substituted long (30 in.) semi-elliptic, or quarter elliptic end springs (as used in the Peckham "Excelsior" truck in America for many years). The second springs are of spiral shape. With quarter elliptic springs two spiral springs are used, with semi-elliptic springs only one. The centre truck springs are of spiral shape as in the old construction. The end springs (elliptic and spiral) are made sufficiently strong to support the weight of the over-hang of the car body. The centre of the semi-elliptic end spring is located at the extreme end of the truck frame, which is supported (from underneath) by the cantilever truss, extending from end to end of the truck frame. This change in springs increases the spring-base of the truck 3 ft., making it for a 6 ft. wheel-base 15 ft. 2 in., and for a 6 ft. 6 in. wheel-base 15 ft. 8 in. This increased spring-base supported by the "cantilever truss" in combination with the end tension springs controls the motion of the car, and makes it ride more smoothly and without teetering. This change in springs is applicable to both the standard and extra long old style Peckham trucks, and can be easily and economically made.

The Peckham system of trucks includes types adapted to any and all conditions of railway service from a 16 ft. single-truck car to a 70 ft. high-speed double-truck car.

For the past three or four years the Peckham Company have made a speciality of high-speed double trucks, and have equipped in America over forty high-speed railways running from forty to fifty miles an hour, and in one instance, the "Aurora and Chicago Railway," over sixty miles an hour. They have furnished and have under construction over 1,200 double trucks for the Brooklyn Heights Railway, of Brooklyn, New York. They have over 6,000 single and double trucks in greater New York City. Within the past two years the Peckham Company have constructed a new plant and equipped it with the most modern machinery especially adapted for the manufacture of Peckham trucks.

The Peckham Manufacturing Company's offices in London are at Queen Anne's Chambers, and the company is now prepared to furnish either of the above styles of "cantilever trucks" or any of their various styles of maximum traction, short wheel-base, or high speed double trucks.

MUNICIPAL TRAMWAYS' AMATEUR FOOTBALL LEAGUE. The winners of the shield, for the season 1904-5, are the Sheffield Tramways Central Football Club, who out of eight matches won six, lost one, and drew one. The following table shows the position of the clubs at the close of the season:

	Played.	Won.	Lost.	Drawn.	Goals For.	Goals Against.	Points.
Sheffield	8	6	1	1	18	5	13
Manchester	8	6	2	0	21	10	12
Liverpool	8	2	4	2	8	16	6
Southport	8	2	5	1	10	20	5
Wigan	8	1	6	2	8	14	2*

* Two points deducted by order of League Committee, January 17, 1905.

In forwarding the shield to the Sheffield club, Mr. C. R. Bellamy, the president of the league, congratulated the tramway men of Sheffield on being the first holders of the trophy, and on their splendid victory after a well-fought contest.

THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, of Rugby, in their pamphlet No. 178, give a full description of their voltage regulators for alternating and continuous-current generators. The diagrams show conclusively and by actual tests the utility of the apparatus in ensuring a uniform voltage with varying speeds and loads, and the disadvantage, in the case of lamps, of such variation, for "a slight increase of voltage above normal is very detrimental to the life of a lamp, whilst a slight reduction seriously reduces the candle-power."

HYDRAULIC RAIL TOOLS.

The firm of Messrs. Youngs, Ryland Street Works, Birmingham, is well known to tramway and railway engineers as makers of rail benders, pulley blocks, lifting jacks, hydraulic tools, and other appliances required for tramway and railway constructional work, and the machines here illustrated will no doubt prove interesting to all engaged in the construction and upkeep of railways and tramways.

The convenience of hydraulic power for punching and shearing purposes, and its adaptability for portable

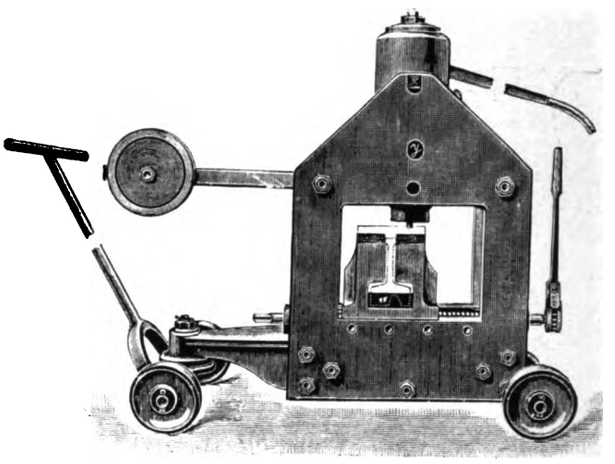

Fig. 1.

work, are exemplified by the portable hydraulic punching machine (Fig. 1.) This machine has two massive wrought-iron frames between which at the top are the combined cistern and cylinder with the ram, the cistern containing a gun-metal pump and a ram carrying the punch. In the centre of the machine and resting inside the gap is a cast-steel die block which is traversed

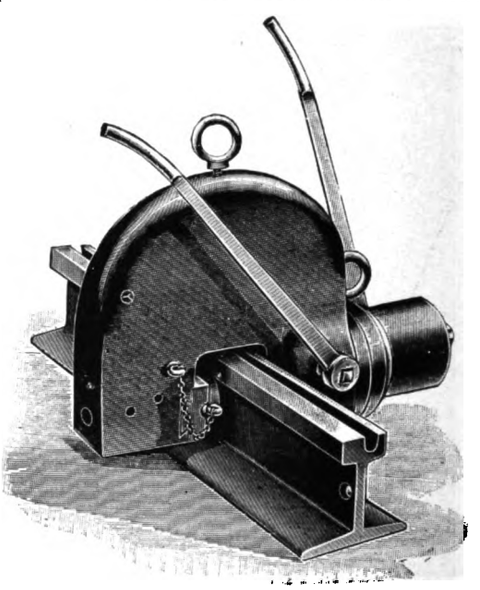

Fig. 2.

from side to side by means of a screw and ratchet handle. The die block is made with a slot in the centre to take the rail, flange uppermost, and on each side of the slot a die is placed at centres to suit requirements. A suitable stop is provided, so that by traversing the die block either die can be brought immediately under the punch as desired, thus allowing holes to be punched on either side of rail flange without handling the rail beyond moving it endways through the machine. The

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whole is mounted on two axles with four road rollers, the front axle being made to swivel. The machine is drawn along by means of a T drag handle.

This tool embodies every improvement in hydraulic punching machines necessary to make it a most thoroughly efficient appliance for punching tram rails,

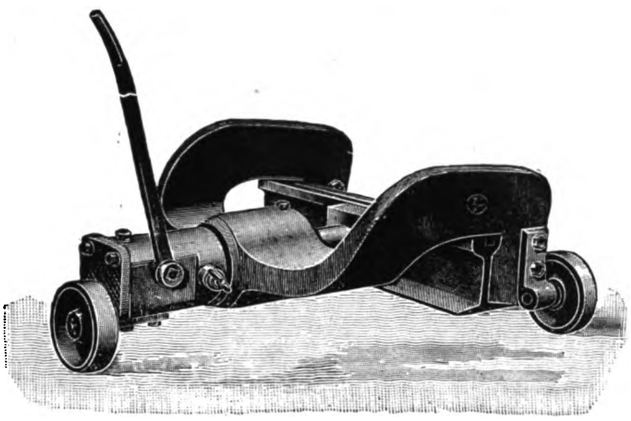

Fig. 3.

slot rails, tees, and other sections used in tramway construction. A number of these machines are now in use, and are giving the greatest satisfaction as labour-saving tools.

Fig. 2 shews a special hydraulic punching bear for punching rails whilst in position, which has been of

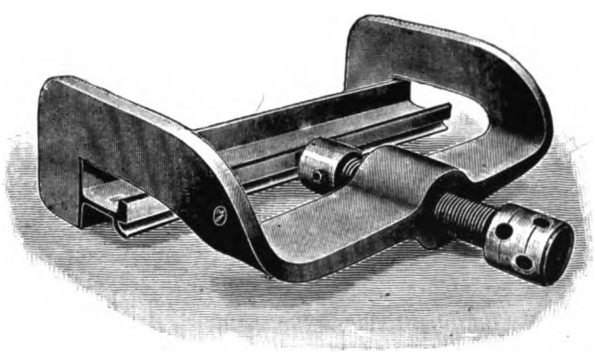

Fig. 4.

great service in tramway construction. This design differs from the ordinary pattern inasmuch as the die is carried in a steel die block which slides in and out of the mouth of the bear, the body having a dovetailed groove for the purpose; this allows the die to be removed from the bear altogether, and the gap being thereby considerably widened the head of the rail can be inserted from the front, which is an immense advantage when it is desired to punch the rails in position. A stop is provided to keep the die block in position, and an eye is screwed in the back of the body so that the bear can be handled by a crane or other appliance.

Fig. 5.

In Figs. 3 and 4 are seen the general design of Youngs' special machines for bending tramrails. Fig. 3 shows a hydraulic rail bender. This bender is machined to take the larger side of the rail when it is of nearly uniform section, but when the rail to be operated upon is of unequal section two sets of bearing blocks are recommended to fit upon the claws with two swivelling shoes for the point of the ram. The two sets are interchangeable, and are shaped exactly to fit the contours on each side of the rail respectively, and by their use the rail can be bent from either side to better advantage. Fig. 4 shows a screw rail bender for bending a rail in the depth.

The special feature of Youngs' patent worm screw pulley block (Fig. 5) is that it is automatically self sustaining without the aid of the usual ratchet and pawl and spring. The ratchet and pawl alone are unreliable, and this has caused some to attach a spring to the pawl to keep it in the ratchet wheel, but the spring also is apt to get out of order, with the result that the load frequently runs away and causes great danger to those working the blocks. Youngs' patent worm block brake consists of two cams turned on the worm spindle, which fits into two brass segments held in the front end of a brake box by a cap. In the back end of the brake box is a split cone ring, which fits on to a cone which is cast on the bracket. When lifting the load the brake box remains stationary, being held by the frictional contact of the split cone ring on the inside of the brake box, whilst the cams driving forward carry the brass segments freely round in the brake box. Immediately hoisting ceases the backward pull of the load operates the cams and expands the segments, wedging them against the side of the brake box, which is held stationary by the frictional contact of the split cone ring on the brake box, and thus sustains the load. To lower the load the hand chain is pulled in the reverse direction, when the brake box is carried backward with the spindle, and the friction at the periphery of the split cone ring (which is just sufficient to sustain the full load) being easily overcome by the pull on the hand chain, the load descends.

This arrangement renders the brake entirely automatic in its action, and correspondingly easy in its working, as the frictional brake-power is always in direct proportion to the weight which is being lifted, whilst the entire absence of springs, ratchets, and pawls removes all sense of insecurity and doubt, and renders the block more safe, and at the same time more easy and reliable in its working.

Municipal Economy in St. Petersburg.—The committee appointed to examine a project to operate the St. Petersburg electric tramways by power generated at the waterfalls on the Vuoks River in Finland have recommended the abandonment of the idea, on the ground that the estimated expense of £2,500,000 would involve a debt that would hamper the town for a century.

Dick, Kerr and Company, Limited, Abchurch Yard, Cannon Street, London, have issued a copiously illustrated book dealing with tipping wagons and rolling stock for portable and light railways. The firm have supplied their portable light railways and rolling stock to mines, factories, docks, etc., all over the world, and their long experience has enabled them to produce and standardise an immense variety of wagons and other appliances for such railways, and for contractors' work. Strength and simplicity have been fully considered in design and construction, while careful attention has been given to details. Among other items dealt with in the book are locomotives for portable and light railways, haulage gears, pit cages, steel wheels and axles, axle boxes, springs, and light railway rails.

Trams and Motor 'Buses.—The remarks made by the chairman of the Brush Electrical Engineering Company, Limited, at the recent annual meeting appear to express the view taken by practical traction people as to the relative spheres of usefulness of the electric tram and the petrol motor 'bus. "We have felt," said Lord Vaux of Harrowden, "that in the evolution of the automobile we would find a public service vehicle which should prove a useful auxiliary to tramways and light railways by acting as a feeder to them and as a pioneer to the extension of the different systems. The extent to which the one will overlap the other will settle itself in due course, but it is probable that they will be allies rather than rivals. As large makers of rolling stock, it is necessary that we should be in intimate touch with such developments. We have therefore taken occasion by the hand, and have been already building motor 'buses."

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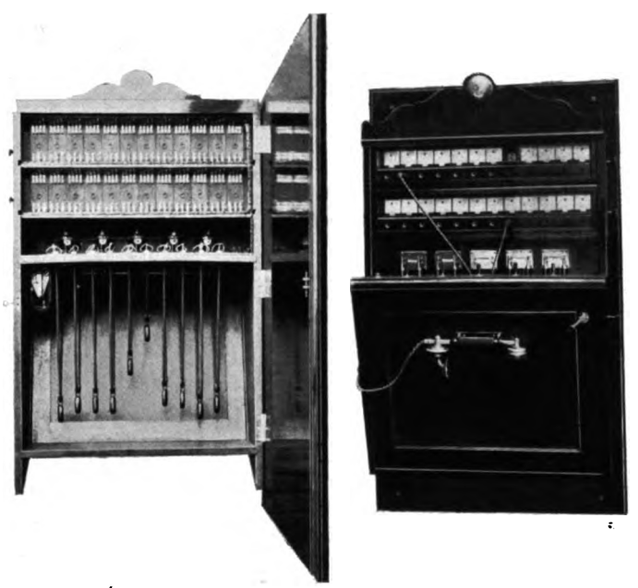
GENERAL ELECTRIC COMPANY'S TELEPHONE WORKS.

In view of the fact that the telephone plays a considerable part in the operation of electric tramways, the General Electric Company recently invited a number of representatives of the Press to visit their works at Salford, and to examine the processes of manufacture of telephones for tramway and other purposes. The instruments specially designed for tramways are of the highest class, and in common with the exchange apparatus for use in public switch rooms, forms an important part of the business that engages the attention of the large staff of skilled workmen. The total number of hands employed in the Peel Works of the Company is 1,750, of whom about 1,100 are engaged exclusively on telephone and telegraph work. Telephones and accessories are made for all classes of work. Large numbers of telephone switchboards are turned out, both of stock designs and of special designs to suit special conditions. The largest switchboard hitherto made in one section is for 1,000 lines. The majority of the boards turned out range from 10 lines to 250 lines.

An interesting feature in telephone work, from a



Telephone Switchboard.

manufacturing point of view, is the varied number of materials employed, the large number of separate parts which have to be handled, and the great number of manufacturing processes on these parts. The materials regularly employed in telephone manufacture are various kinds of hard wood, iron, steel, copper, silver, platinum, zinc, brass, aluminium, phosphor bronze, German silver, gun metal, bell metal, nickel, and tin. The insulating materials are ebonite, vulcanised fibre, bone, horn, ivory, silk, cotton, india-rubber, gutta-percha, porcelain, millboard, mica, and paraffin wax. Carbon is, of course, extensively used in various shapes and forms in the construction of transmitters and lightning arresters.

Even in a comparatively simple instrument there are a large number of distinct parts, and as each part undergoes several processes in the course of manufacture, the total number of processes on one set amounts to something over 600.

It is evident that the peculiar point in a telephone factory turning out a large number of different patterns is the complexity of the operations, and the difficulty of tracing every process on every part of every telephone from point to point, until each part is incorporated in the finished instrument, and ensuring that no single process shall be missed or incorrectly performed. A perfect system of organisation is absolutely essential, and in the Peel Works the drawing is made the basis and the key of the whole position. This was pointed out to the visitors in detail, and it explains why it is thought necessary to provide such elaborate drawings in every instance.

The parts required for any order are assembled in a special room in the stores, and in this room a record is kept and posted up from moment to moment, showing the exact position of every part required for that order. No instrument, however small, leaves the works without being subjected to two tests, first, by the foreman under whose charge the instrument is fitted up and, secondly, by an entirely independent test department.

In the coil-winding section, the number of coils turned out weekly averages 10,000. All of these are tested for insulation and resistance several times before they finally leave the section, as well as being finally tested in the complete instrument.

The whole of the tools required for the power presses, hand presses, drop stamps, turret lathes, and automatic screw-making machines are made in the works' toolshop, as well as all the special tools required for wood-working machinery. The shop also maintains all the works' plant. Every individual screw used in the telephones (with the exception of wood screws) is made in the works, the total number turned out being many millions annually.

The General Electric Company commenced the manufacture of telephones in 1888, and have extended the work year by year since. It has now been decided to use the whole of Peel Works as a telephone and telegraph factory as soon as new works can be built for the other work now being done there.

A special feature of the Peel Works is its completeness; all the different types of instruments which the General Electric Company are now offering for sale are manufactured throughout upon these premises, and the utmost care and attention paid to the most minute detail.

London County Council Pocket-Book of Workmen's Trains, etc.—The eighth number of the pocket-book prepared by the London County Council showing the number and times of running of workmen's trains on all the metropolitan railways, and of workmen's cars on the London tramways, has been issued. Considerable alterations have been made in the workmen's service on some of the railways and tramways, and the present issue includes all these. It also contains particulars, as far as they can at the present stage be given, of the service of steamboats to be shortly established by the Council on the river Thames. The pocket-book gives the usual information about the dwellings for workmen provided by the London County Council, and the evening classes in the Council's schools. It may be regarded as an indispensable book for the London working classes, and as it is sold at a penny per copy, they can have no difficulty in procuring it.

The Glacier Anti-Friction Metal Company, Limited, 91, Queen Victoria Street, London, E.C., have issued a little pamphlet giving the results of tests comparing their metal with "Genuine Tin Babbit," on which it is an improvement. The past standard of most Governments has been a genuine babbit containing 80 per cent. of tin, which is the most expensive alloy on the market. In the case of electric tramcars it is claimed that the glacier metal bearings ran 5,000 miles more than the babbit ones, owing to the perfect homogeneity of the former. The metal can be used over and over again, by adding a little fresh glacier to each re-melt, and it can be melted in an iron pot or ladle.

The British Thomson-Houston Company, Limited, of Rugby in their pamphlet No. 179, describe some of their switchboards for high-tension alternating-current, and units control either motor or mechanically-operated switches, for continuous-current, or for both. The list of stations in which their boards have been fixed fill three pages of the pamphlet, and includes the Lots Road station of the Underground Electric Railways, besides nearly thirty other stations in London alone.

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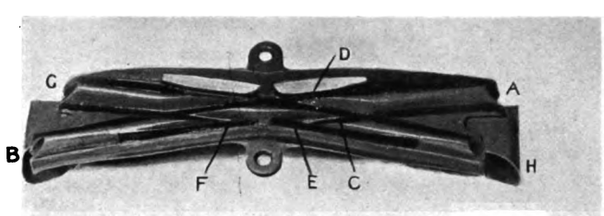
IMPROVED OVERHEAD CROSSING.

Crossings and frogs are a necessary evil on overhead tramway work, and the erratic behaviour of the trolley at these points is often the principal cause of trouble. The smaller the angle of the crossing the greater is the liability of the trolley to take the wrong wire. If combined with a narrow angle crossing the trolley wire is a side-running one, and there is a certain amount of overhang on the trolley wire, this trouble is still further intensified. When a trolley is advancing through a crossing on to a trailing frog, there is more liability of damage to the overhead gear than when it is travelling in the reverse direction. Should the trolley take the wrong wire under these conditions, the mechanical frog that it would meet on this wire presents a most effective trap, and serious damage to the trolley head and overhead gear frequently ensues.

On the Burton-on-Trent Corporation tramways narrow angle crossings, about 16 degrees, are used with a certain amount of overhang on the trolley, due to the cars not running centrally with the trolley wire round the junctions. Damage to trolleys and overhead gear has been of frequent occurrence, and after numerous experiments to better matters, an improved design of crossing was brought out by the general manager, Mr. P. J. Pringle, and it has been the means of reducing the troubles to a negligible amount.

The crossing is shown in the accompanying illustration. In designing this an attempt has been made to get in practice a continuous through rail without any



Burton Overhead Crossing.

complicated gear or mechanism to effect it. If we presume a trolley wheel passing from A to B, there is always a possibility of it fouling the point C at the centre diamond and being thrown off the crossing. That part of the crossing marked D acts as a guard rail and prevents this occurrence, and practically gives the equivalent of a continuous rail to the passage of the trolley wheel at this point. On the trolley wheel still further advancing, the hard phosphor bronze spring piece E is quite lightly sprung to one side, and then the flange of the trolley wheel meets the phosphor bronze spring piece F, guarding it from any possibility of taking the wrong wire. On the trolley advancing from G to H the same cycle of actions takes place.

If a trolley head is taken in one's hand and applied to this crossing, no amount of side pressure or speed in passing across will permit of the trolley taking the wrong rail or being thrown off.

All the crossings on the Burton-on-Trent Corporation tramways have been equipped with this pattern for the last six to eight months, and have proved most effective. The spring pieces are made a good length (about 7 in.), and are therefore quite flexible, so that the amount of wear on these due to the trolley wheel springing them open is exceedingly small, and they will have a considerable life. The replacement of them when necessary is arranged so as to be quite a simple matter. We understand that the British Insulated and Helsby Cables Company have taken up the manufacture of this crossing.

TRAMCAR ROUTE INDICATORS.

We give below two illustrations of the "Acme" indicator, the invention of Mr. A. K. Baylor. It can be made up of practically of any material or to any design required. The main feature of this indicator is that all wearable parts are interchangeable and removable at will. The principal advantages of this particular indicator over others is that the front frame, to which is attached the whole of the internal mechanism, is removable at will by simply turning two thumb clips, one at either side of the indicator. Consequently, instantly on removal of the front frame from the body

of the indicator, the whole of the working parts is available for adjustment, repairing, etc. The screen and rollers are removed from the bearing brackets by turning a wing nut on either side of the frame and raising the clamps. The screen itself is removed from the rollers merely by sliding the rollers off either end, the screen being held in position in a groove in each roller by means of a steel rod being passed through a hem at either end of the screen.

The screen is operated by means of a loose, or fixed, key passed through a brass bush in the side of the indicator exactly opposite the ends of the rollers, the key being made up on the principle of the railway door type. In the case of single-deck cars a special operating gear is fitted which enables the driver of the car to change the destinations from the platform.

The standard indicator is fitted with a removable lampboard which is provided with fittings for one, two, or more lights as desired. This lampboard is held in position by two brass clips which also act as contacts between the lampboard wiring and the lighting circuits of the car. The particular advantage of this lampboard is that in case of accidents through burn-outs it

is only necessary to withdraw the lampboard and replace it by a spare one carried on the car.

The Simplex Steel Conduit Company, Limited, Westinghouse Building, Norfolk Street, Strand, W.C., have published a pair of neat little booklets in maroon binding, and with rounded corners. The first, of 129 pages, is by Mr. Lawrence M. Waterhouse, M.Inst.E.E., A.M.Inst.C.E., a member of the International Society of Electricians, whose object it has been "to give practical and detailed information concerning the various parts of the simplex system and their application in practice." This object he has successfully attained, the system having now been before the public for seven years. The second booklet, of 123 pages, is a price list, which complements in every way Mr. Waterhouse's work; so that by means of these little volumes no possible difficulty would be experienced anywhere in installing the system to the best advantage.

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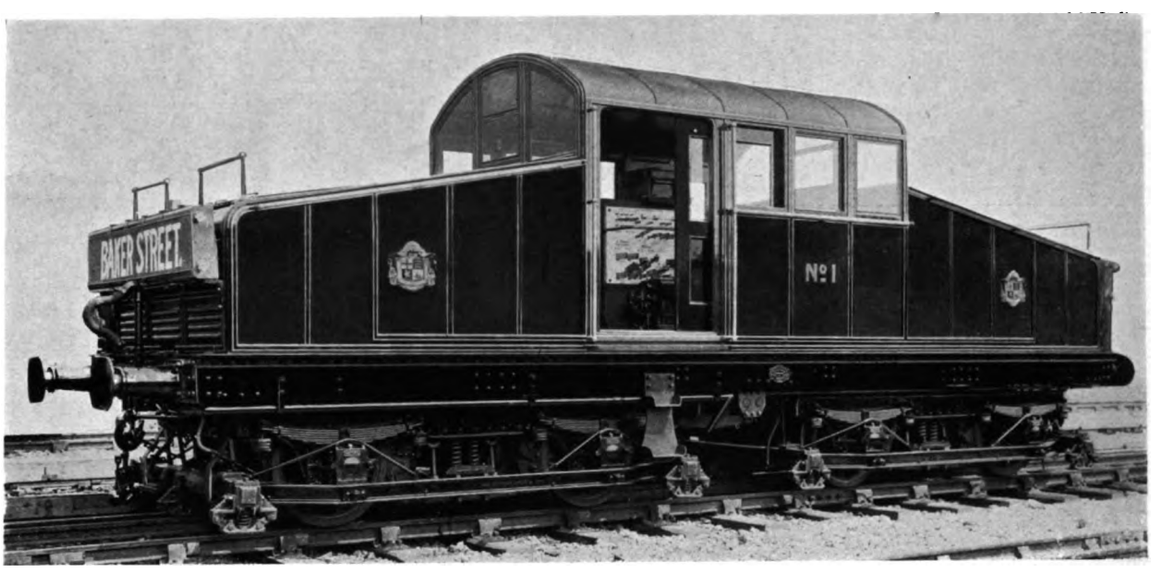
NEW WESTINGHOUSE ELECTRIC LOCOMOTIVES.

The first of ten 50-ton electric locomotives has just been supplied to the Metropolitan Railway by the British Westinghouse Company. These locomotives will be used for hauling the main line trains between Harrow and Baker Street, the steam engines being taken off at the former point and put on at the return journey. The trains used on this portion of the line are 120 tons in weight, and the new locomotives will propel them at a speed of 36 miles an hour. The same locomotives will be used on the Metropolitan section of the Inner Circle for goods traffic and for hauling the rolling stock of other companies with running powers over this line. The electric locomotive will pick up the train at Edgware Road, and be replaced by a steam locomotive at the point where the train leaves the circle. The new locomotives will be equipped with four motors of 300 H.P. each. Owing to the terminus facilities being somewhat restricted, it has been necessary to use motors of a smaller size than usual, equipped with forced ventilation, so as to keep down the length of the locomotives to convenient limits for handling at the termini.



Westinghouse Electric Locomotive for the Metropolitan Railway.

During the visit of the delegates to the International Railway Congress at the Westinghouse works at Pittsburg, on May 16, a great deal of interest was attracted by the new 1,500 H.P. Baldwin-Westinghouse single-phase alternating-current electric locomotive in use on the Westinghouse Interworks Railway. This locomotive has just been completed by the Westinghouse Company and Baldwin Locomotive Works, and is in two parts, connected and controlled by the unit-switch system. The complete weight is no less than 135 tons, and the total length over buffers is 45 ft. The maximum height, with trolley down, is 17 ft. The drivers are 60 in. in diameter, and the distance between centres of drivers is 6 ft. 4 in. The extreme width of the locomotive is 9 ft. 8 in. The locomotive is equipped with six single-phase, single-reduction motors, having a normal capacity of 225 H.P. each, with gear reduction of 18·95. Induction regulator control is used with pneumatically operated trolley. The air-brake equipment is combined automatic and straight air, with pneumatic sanders to sand tracks in both directions. The locomotive is designed to operate on 6,600 volts trolley voltage, with a voltage of 140 to 320 on the motors, and has a draw-bar pull of 50,000 lb. at a speed of approximately 25 to 30 miles per hour.

THE INTERNATIONAL RAILWAY CONGRESS.

The great gathering of railway men at Washington a month ago presented a number of interesting characteristics. The excellent arrangements of the organisers, the splendid collection of railway appliances at the exhibition, and the truly representative and international character of the gathering, all assisted in making the seventh session of the International Railway Congress an unqualified success; but one is inclined to attach chief importance to the prominence given, both in exposition and debate, to the subject of electric traction. Four papers were presented on this topic; while at the Railway Appliance Exhibition, presided over by Mr. George Westinghouse—a household name in the electrical world—the interest taken in the new mode of traction was particularly marked. Many of the delegates stated that one of the principal objects of their visit was to study the progress made in electric traction in the United States, and, doubtless, the examples of what the New York Central and the Pennsylvanian Railroads are doing in America, taken with the reports from this country and the Continent, have given them much to reflect upon in connection with the coming motive power. Meantime, the tramway man, both in this and in other countries, will do well to anticipate that a new era of competition with his special means of locomotion is about to dawn. Electric tramways have been filching traffic from city and suburban steam railways. The latter are now adopting electric traction with all its advantages for such work, so that the tug of war is about to begin. It will be a case of Greek meeting Greek in a new sense, and some time will elapse before there is any sort of definite adjustment of relations. In any event, as time goes on, the International Railway Congress will have plenty of information and judicially balanced conclusions on the subject.

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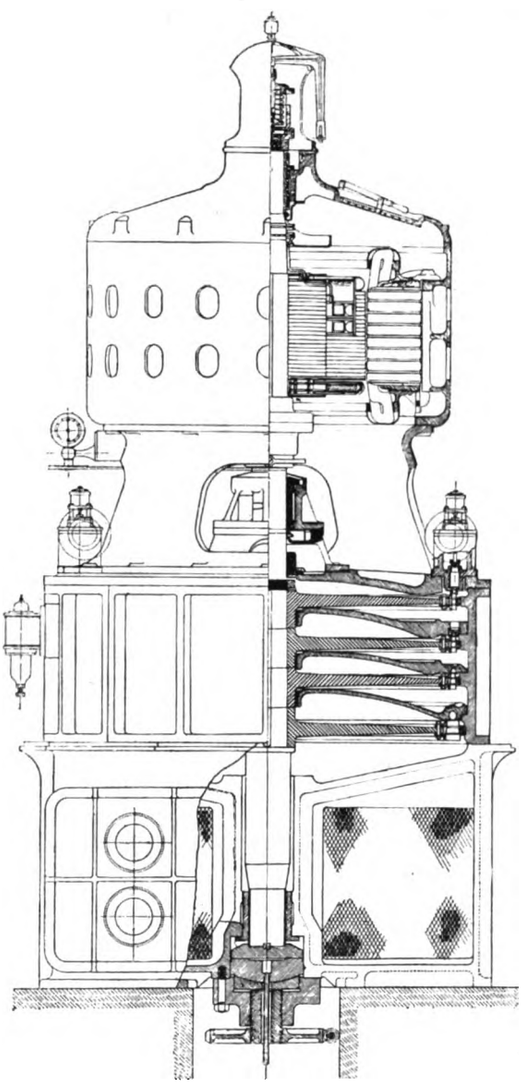
THE CURTIS TURBINE.

The British Thomson-Houston Company, who control the patent rights of the Curtis turbine for Great Britain and Ireland (except for aerial and marine propulsion), are now carrying out the entire manufacture of these machines at their Rugby works.

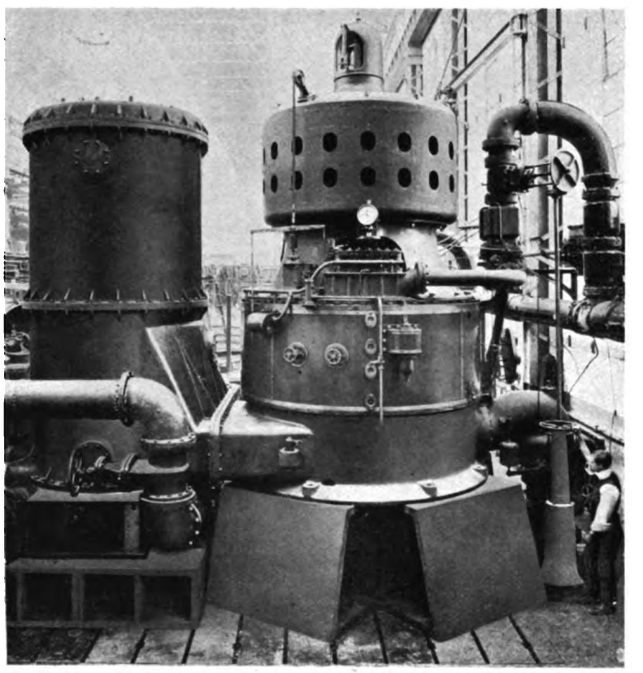
The Curtis turbine is of the "impulse" type, and is so designed as to enable moderate rotative speeds to be obtained in a machine of simple and compact construction. Velocity is imparted to the steam through groups of expanding nozzles, so designed as to effectively convert its potential energy into kinetic energy. After leaving the nozzles the steam passes successively through two or more rings of buckets on the rotating



Section of Curtis Turbine.

element, interspersed with reversed buckets on the stationary part of the turbine. The function of these stationary buckets or "intermediates" is to re-direct the steam received from the rotating buckets so that it will effectively impinge upon the next set of rotating buckets: the steam thus passes through the turbine, rebounding alternately from the stationary to the rotating buckets until it is brought to relative rest, and by this means a high steam velocity is efficiently used to impart motion to an element which moves at a comparatively slow speed.

An important feature in the Curtis turbine is the method of governing; this is effected by a group of steam admission valves under control of the governor. These valves distribute the steam to the first set of nozzles, the number open at any time being proportional to the load. The relative position of the admission valves, nozzles, moving and fixed buckets, in a two-stage turbine is indicated in the accompanying diagram.



1,500 Kw. Three-Phase Curtis Generator.

11,000 Volts on Test.

With such weights and speeds as are dealt with in all steam turbine work, forced lubrication is in any case compulsory, and it is most simple and direct in its action when applied to a pressure step bearing such as is adopted with the larger Curtis turbines. The footstep bearing affords a practically frictionless support, and, at the same time, maintains an exact adjustment of the relative positions of the stationary and rotating parts, thus removing the necessity for any other thrust

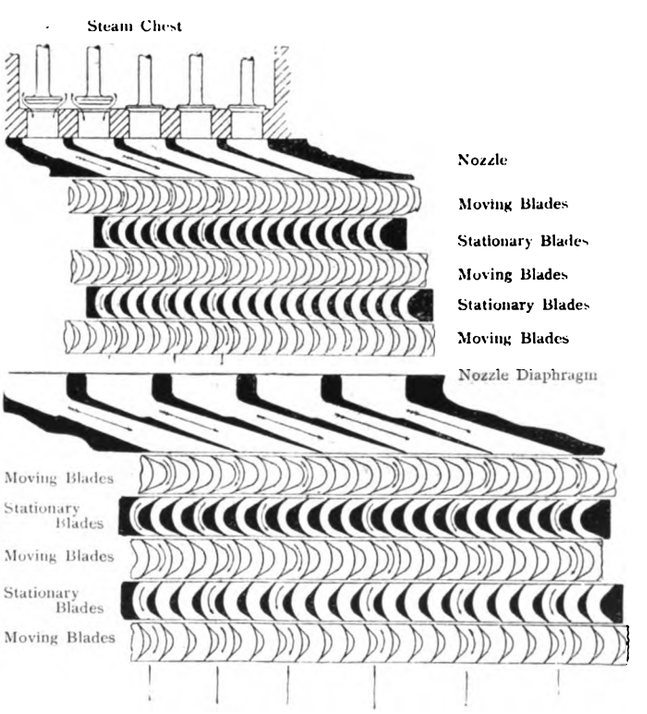


Diagram of Nozzles and Buckets in Curtis Steam Turbine.

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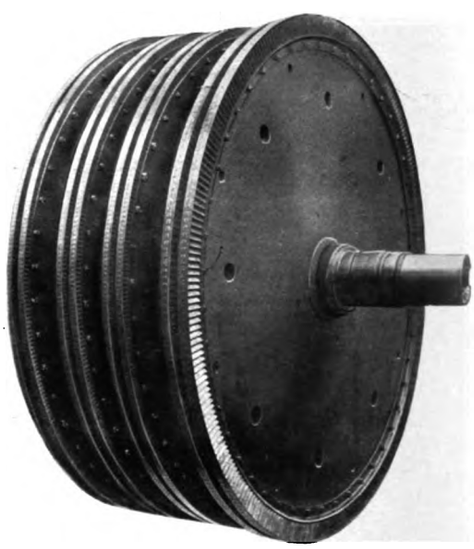
bearings. The fact that the rotating element of a 1,500 KW. set can easily be turned round by hand is striking evidence of the very small amount of friction. The foot-step bearing is placed in the base, and is removable from below, an opening for this purpose being provided in the foundations. The bearing itself (which supports the whole rotating element of the turbine) consists of two circular bearing blocks, one of which rotates with the shaft and the other is fixed to the base. Water is used as a lubricant, being forced through a hole in the stationary bearing between the two surfaces from the centre outwards, in a thin film. From the foot-step bearing, the water passes upwards and lubricates a guide bearing which is placed immediately above it, afterwards passing into the turbine base from whence it is removed with the condensed steam: with this arrangement no shaft packing gland is required at this end of the turbine. The two upper bearings, which have practically no load to carry, are lubricated from a small oil pump attached to the shaft of the pressure pump. All the bearings are easily removable without disturbing the turbine or generator.

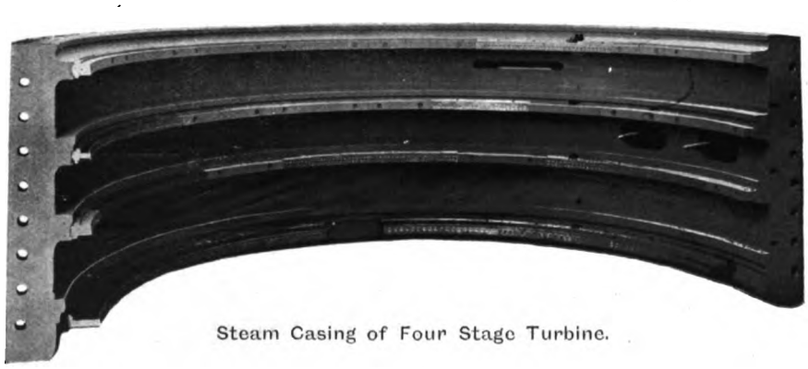
The revolving buckets are cut out of a solid ring by machinery specially designed for the purpose. The stationary intermediates are also of solid metal, and thus the accidental loosening of buckets is rendered impossible. The nozzles are specially shaped, and their openings are accurately proportioned to give the desired degree of expansion in each stage.

Revolving Bucket Ring.

Fourth Stage Diaphragm Showing Nozzles.

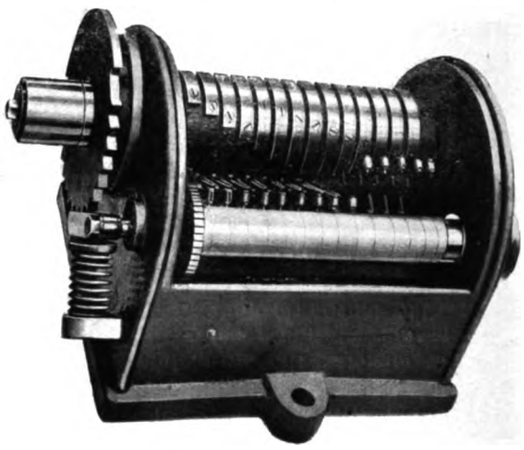


Revolving Wheel of Four Stage Turbine.



Steam Casing of Four Stage Turbine.

In order to secure high economy it is desirable to maintain between the stationary and revolving buckets the smallest possible clearance in a direction parallel to the shaft, consistent with security against rubbing. The clearance is adjusted by means of a heavy screw bolt at the bottom of the foot-step bearing. This bolt supports the foot-step blocks, and on the larger machines is operated by worm gear. A very delicate adjustment is easily obtainable. Inspection holes are provided in the turbine casing to enable the clearances between the buckets to be readily observed. From the method of construction adopted it is impossible for any injury to be done to the buckets by any reduction in the normal clearance.



Electric Controller.

The governor is of the centrifugal spring loaded type, and is generally set for a speed regulation of 2 per cent. between full load and no load, with a maximum momentary variation of 4 per cent. For the purpose of synchronising, and to enable the turbine to take its proportional share of the load, a supplementary spring is introduced which acts in conjunction with the main governor spring, and allows the speed of the turbine to be varied 2½ per cent. above or below the normal. The governor is connected to an electric controller, which opens or closes the circuits of a series of electro-magnets. These electro-magnets operate pilot valves, which, in turn, open or close the main steam admission valves. These latter are of the "balanced" type, and they are opened or closed by the difference in pressure of the steam which is admitted on either side of them. Their action is therefore a positive one, and is independent

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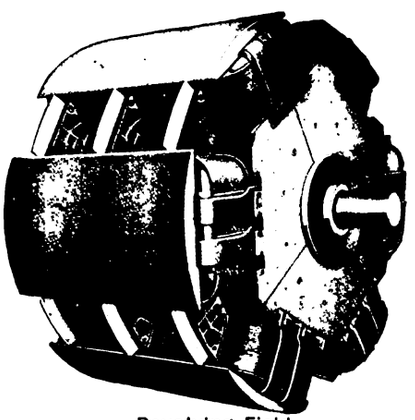
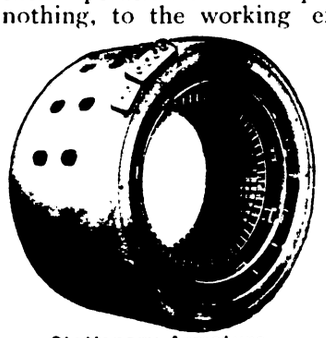
of the power of the electro-magnets, these latter being quite small. An emergency governor is provided, the function of which is to automatically shut off steam should the speed exceed a pre-determined limit.

The operation of a Curtis steam turbine at light load is virtually the same as at full load, except that the belt of advancing steam is narrower. Experience has shown that very little diminution in economy results from this narrowing of the active steam belt, and consequently the efficiency at light loads is exceptionally good. The increased power for overloads is obtained by the opening of additional admission nozzle sections, *i.e.*, by widening the belt of advancing steam which impinges on the buckets. It is thus possible to operate the Curtis turbine from half load to 50 per cent. overload, or more, with very little change in steam economy throughout the entire range. The Curtis turbine operates at high average efficiency and is capable of taking full advantage of the highest degree of expansion to which steam is susceptible. The steam is expanded to a considerable degree before it reaches the first buckets; the initial high temperature in the steam is therefore not a source of difficulty or deterioration. The Curtis turbine is designed to utilise to the best advantage the highest attainable degrees of vacuum, and it has been found from experience that there is no difficulty in obtaining these high vacua. This is due to the absence of leaky glands and the shorter and more direct path for the exhaust steam.


Revolving Field.

Owing to the restricted expansion of steam in a reciprocating engine, low-pressure Curtis turbines can in many cases be utilised to advantage in conjunction with existing reciprocating engines. The turbines take steam from the exhaust of the engines without the intervention of valves or governing mechanism, and their operation is so simple that they add little, or nothing, to the working expenses and maintenance cost of the station. With suitable condensing facilities, it is possible, by the use of low-pressure turbines, to increase the output of a reciprocating engine station some 20 per cent. to 30 per cent. without adding to the coal consumption.


Stationary Armature.

All Curtis turbines (with the exception of some small sizes) are designed to operate condensing, but they are arranged so that they can be used non-condensing if necessary. Surface condensers are usually to be recommended, as by their use absolutely clean hot feed is available for the boilers, there being no oil used in the interior of the turbine. With sets of 500 KW. and upwards the standard arrangement, where feasible, is to mount the turbine direct on the condenser casing. This makes a very compact and efficient arrangement.

For alternating current the alternator has a stationary armature and revolving field. The armature is built up of annealed punchings, which are rigidly held in a cast-iron frame, suitable spaces and openings being provided to ensure ample ventilation: special precautions are taken to avoid undue noise. The revolving field is of laminated construction, accurately balanced and keyed to the shaft.

The design of the continuous-current generator does not differ essentially from that of engine-driven generators, except that ample provision is made to take care of the increased centrifugal force due to the higher speed. The construction of the commutator and brush gear has received special attention. Insulated steel rings are shrunk over the commutator to afford extra protection against centrifugal stresses, and the brush gear is of great rigidity in order to prevent vibration. Carbon brushes are used throughout with very satisfactory results. The generator can be supplied either shunt or compound wound.

In conclusion, the principal advantages of the Curtis turbine may be summarised as follows: Saving in floor space, foundations, attention, and oil. There is no oil in the steam, and the construction is simple. The low rotative speed of the Curtis turbine very much simplifies the construction of the electric generator, and it is claimed enables a more satisfactory design to be used than has been possible with higher turbine speeds. The continuous passage of steam through the turbine eliminates the tendency to pulsate, and thus ensures perfectly uniform angular velocity. This property is of the highest importance in the parallel operation of alternators, especially where rotary converters or other synchronous apparatus is used.

The steam consumption of the Curtis turbine operating under proper conditions is at full loads equal to, and at partial loads superior to, that of a reciprocating engine of equivalent power. On rapidly fluctuating loads, such as are met with in electric railway or tramway power-stations, the overall efficiency of the Curtis turbine shows a very marked superiority.

The simplicity of construction of the Curtis turbine ensure silent running and a minimum of deterioration. High pressure and superheat are permissible, and there is no danger from water carried over from the boilers. The Curtis turbine can be started up immediately on an emergency. Indeed, it has been found possible, in actual practice, to take full load on the larger sizes in three to five minutes from notice to start up, the turbine being quite cold at the time.

The Curtis turbine in its perfected form was only placed on the market after several years of careful experiment and test. It met with immediate success, and during the first three years contracts were obtained from all parts of the world for Curtis turbo-generators, aggregating a total of some 600,000 H.P.

THE LOCOMOTION PROBLEM, by Charles Bright, F.R.S.E., 75 pages, 8½ by 5½ in., price 1s. (P. S. King and Son.) It is rather difficult to understand the *raison d'être* of this publication, which is simply a reprint of three "popular" lectures (as they may be called) delivered by the author "a little time before the Motor Act came into being." They are, therefore, slightly out of date, and are given with all the repetitions (for which the author apologises) which naturally occurred in lectures delivered in different times and places. Surely, if it was worth while reprinting them at all (which is, perhaps, doubtful), it ought to have been worth while to edit them properly. The author refers the student of the problem to what may be described as rather a "mixed lot" of authorities, viz., Harmsworth's "Motor and Motoring," "The County Gentleman," "Electrical Investments," Garcke's Manual, Madgen's "Industrial Redistribution," Mr. Whyte's "Business of Electricity," and last, but not least, Mr. Bevan's "Tube Trains, Tram and Car." The author is heavily facetious in parts, especially when he splits infinitives, but passages such as the following are really too awfully funny for words: "By the temporary exercise of stringent regulations we may soon wipe out the motor 'scorcher,' who is usually furnished with more money than culture, or even brains, and who, therefore, fails to exercise that consideration for others such as the natural heritage of gentle folk."

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THE LIVERPOOL GUARD.

An inquest was held on the 11th ult. on the body of a passenger who was killed by a electric car on the Liverpool Corporation Tramways. The man appears to have fallen head first from the top of the car, striking the dashboard and falling on the line. It appears from the evidence that the plough lifeguard, instead of pushing him aside, passed over his head, arms, and body, killing him instantly. Mr. Bellamy, the tramway manager, stated that on the morning after the accident he examined the lifeguard on the car and found it was adjusted in the usual way, with a fixed clearance of two and a half inches from the railhead. He found it difficult to reconcile his knowledge of the plough guard with the suggestion that the body had passed beneath it. The case stood out because of their immunity from accident in Liverpool compared with other places. He was convinced they had the best guard in use in Liverpool, and they had also the best record. The guard had never failed before, and it had been in use in Liverpool for three years. He had looked fully into the matter, and was not prepared to make any suggestion for its improvement. The coroner said everything had been done to make the guard as effective as possible, and remarked that last year 123 accidents occurred in which it was efficacious in sweeping the body aside. The jury found that death was accidental.

AN IMPROVED TRAMCAR SWITCH.

An admirable type of tramcar switch is the Diamond H 500 standard switch, manufactured by the Hart Manufacturing Company, Hartford, Connecticut. This special type is illustrated below. It is of a novel mechanism and excellent design, combining with its positive action, great rapidity, and unusual width of break. It has been adopted after one of the most exhaustive trials by the Manhattan Railway of New York, and is also giving entire satisfaction on many railway systems in England. This switch is for operating two circuits of five lights each. Nine lights inside one car, and one light in each vestibule. The nine lights inside and either one of the vestibule lights,

Switch without Cover.

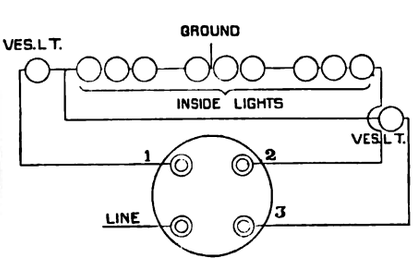

Diagram of Light Circuit.

are cut in at will. The switch is provided with a spring-adjusted handle, which holds the cover securely on the switch by spring pressure. The mechanism is insulated from the current-carrying parts by sheet mica. The cover is lined with fibre, drawn in one piece and not notched or cut to assist such formation. The Diamond H switches are the outcome of long experience and the closest attention to detail, and the manufacturer's assertion that the Diamond H line has "no equal" is not a mere figure of speech.

An illustrated catalogue and other information relative to the Diamond H switches and wall appliances may be obtained at the Hart Manufacturing Company's London offices, 25, Victoria Street, S.W., of Mr. Wm. Crichton, the Company's European manager.

IRRIGATION AND LIGHT RAILWAYS.*

The description of the Leek and Manifold Valley Light Railway, given in the July issue of this journal, demonstrated how a tract of country that had gone to sleep for want of intercourse with its neighbours all round by reason of deficient means of communication —how such a district could be wakened up to new life by restoring circulation, that is, by enabling the produce of the soil to reach consumers at a reasonable cost for carriage, and so enable it to compete with other parts of the country that had not been allowed to slumber. In many undeveloped parts of the world such cheap railways as were described would be of no use unless the lands were first irrigated. In Canada, by one project alone, that of the Canadian Pacific Railway, it is intended to open up three million acres of land, equal to 4,688 square miles, at a cost of about one million sterling. In India, up to April, 1903, some 20 million acres, or 31,250 square miles, had been brought into cultivation by means of canals, and they have yielded crops to the value of nearly £27,000,000, or 88 per cent. upon the total capital expended. Two of the men who have contributed in no small degree to this magnificent result in our Eastern Empire have written a book* which can be safely recommended, not only to the pioneers, for whom it has been specially written, but to all those who desire to bring people back to the land by making it worth their while to cultivate it. It is obviously of no use to grow magnificent crops unless you can sell them to advantage. The authors have succeeded in avoiding technical terms as far as possible, and in describing means which are within reach of all. The parts of the book that most appeals to our readers are Mr. Calthrop's two chapters on light railways. The great experience he has had, both on normal and narrow gauge lines, all over the world, has enabled him thoroughly to realise the practical advantages and otherwise of different gauges; his conclusions, and the reasons for them, are set forth most clearly, and are illuminated by the excellent half-tone blocks accompanying the text.

PETROL MOTORS SIMPLY EXPLAINED, by T. H. Hawly, 116 pp., 19 illustrations, 7½ in. by 4¾ in., price 1s. (Percival Marshall and Company). This is the third of Marshall's Practical Manuals. As the author truly says in the 100 pages of descriptive matter allotted to him it was impossible to convey fully the details of elaborate machines, or of transmission gearing and other outside mechani m. He has, therefore, confined himself chiefly to "making clear the principle of the petrol motor or engine itself," and his little work will be found useful to the rapidly increasing number of automobilists and motor cyclists, by giving them a clear understanding of the general subject, and by enabling them "to assign the proper functions of each part of the engine," and its general method of construction. The work forms a good introduction to more advanced text books, and does not in any way claim to supercede them.

THE DISEASES OF ELECTRICAL MACHINERY, BY ERNST SCHULZ.†—Professor Silvanus P. Thompson in his preface to this *opus urtum*, as the author calls it, compares the electric to the human machine, and avers that they both suffer from congenital, if not hereditary and acquired diseases, due to climate, or youth, or old age, being sporadic or epidemic (!), transient, chronic, curable, or incurable. He goes further and boldly states that, as every profession has its failures, so behind the physician lies the grave-yard; behind the electrical engineer tell it not in Gath—the scrap heap. As the Professor truly says, the survival of the fittest has eliminated the constitutionally unfit, yet for spotting the first signs of anything wrong, and for applying first aid, this little work is eminently fitted. Mr. Schulz has studied the subject for 20 years, and writes with experience. The translation has been well done by Mr. Hugh Ledward, and the price of the work brings it within the reach of all.

* "Pioneer Irrigation," by E. O. Mawson, M.Inst.C.E., Executive Engineer, P.W.D. Bombay, with additional chapters on "Light Railways," by E. R. Calthrop, M.Inst.C.E., M.I.M.E., 34 plates, 91 sigs., pp. 260 + xvi., with index and pp. 64 of advertisements. 8½ by 5½ inches. 1904. Price 10s. 6d. (Crosby, Lockwood & Sons.

† Diseases of Machinery, 84 + x pp., 7 in. by 5 in. by ½ in. Price 2s. net (E. and F. N. Spon).

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ASSOCIATION OF TRAMWAY AND LIGHT RAILWAY OFFICIALS.

NINTH ANNUAL MEETING AND VISIT TO THE BRISTOL TRAMWAY COMPANY'S POWER STATION AND REPAIR SHOPS.

The ninth annual Conference of the Association of Tramway and Light Railway Officials was held on Wednesday, May 3, at the Grand Hotel, Broad Street, Bristol. Mr. H. England (general manager of the Wakefield District Light Railway), president of the Association, occupied the chair.

THE PRESIDENT, in opening the proceedings, said that while they all regretted the somewhat small attendance, they none the less fully appreciated the kindness and attention of Mr. Challenger in arranging for the reception of the members in Bristol.

ADDRESS OF WELCOME TO BRISTOL TO THE MEMBERS OF THE ASSOCIATION OF TRAMWAY AND LIGHT RAILWAY OFFICIALS.

BY CHARLES CHALLENGER

(Traffic Manager, the Bristol Tramways and Carriage Company).

On behalf of the directors of the Bristol Tramway and Carriage Company, Limited, Sir George White, Bart. (chairman), Mr. J. Clifton Robinson, C.E., J.P., Mr. James H. Howell, J.P., and Mr. Samuel White (managing director), I have great pleasure in heartily welcoming you to Bristol. It is one of the most ancient cities of this great empire, but it is, nevertheless, up-to-date. Bristol possesses features of attraction that are calculated to satisfy all tastes, and not the least of these are her architectural and engineering achievements. The world-renowned Clifton Suspension Bridge stands out prominently in connection with engineering; it was opened in 1864; has a single span of 702 ft.; width, 31 ft.; weight, 7,000 tons; height above the river Avon, 290 ft. Also the new docks at Avonmouth, upon which over £2,000,000 is being spent by the city. The Severn Tunnel, opened in 1886, constructed by Sir John Hawkshaw, the longest tunnel in this country, being 4 miles 950 yards, occupied 14 years in construction, and cost £2,000,000. It was from Bristol that John Cabot and his son sailed in 1497 and discovered the Continent of America. It was also from Bristol that the first steamship, the "Great Western," sailed and crossed the Atlantic to America. The watchword of Bristol has always been "Forward," and at no period of the city's history has she been more alive and progressive than at the present time.

Bristol has an area of 11,657 acres and a population of 345,000. In 1904, the electric cars carried 45,312,373 passengers, thus carrying the population almost three times each week, or, in other words, the population of the city was carried during last year 133 times over. The horse tramways were opened 30 years ago, namely, in 1875. The route length to-day is about 30 miles. I may say it is not the fault of the company that there is not double that length of route. Bristol was amongst the first two or three tramway companies in this country to operate horse cars, and it was the first to run electric cars under the Board of Trade rules.

Bristol is very hilly. Historians compare it to Rome, and designate it the City of the Seven Hills. So steep are some of the main roads that several of the highly situated districts had to wait until the advent of electric traction before they could be connected to the city by tramways. Horses could do much, but could not humanely be expected to negotiate such severe grades. The horse-car lines were, however, taken up many of the steep hills, and I have had many times to provide six horses, on holiday occasions, to drag a car load of sixty passengers up the Infirmary Hill, a grade of 1 in 11, and having in addition a curve of about 45 ft. radius. The speed up this hill, with much slipping and straining, was about three miles an hour. Now the nimble electric car, with its two motors totalling 50-horse power, will mount the same hill with 60 or more passengers at the rate of seven to eight miles an hour. Need we any clearer proof of the great superiority of electric power over horse power?

As to the great and rapid strides made by electric traction, I would remind you that it was no longer ago than 1883 that it first became of sufficient attraction to command the attention of tramway managers. In October of that year the Street Railway Association of America held its second annual meeting at Chicago. The secretary, the late Wm. J. Richardson, of New York, sent to me at the time a copy of the report of that important meeting. The president, Mr. H. H. Little, of Louisville, in his address said:

> "The sciences, each with its demonstrated truths and wonderful appliances, . . . have swept humanity forward in its course, until the steam engine, the ocean steamer, the telegraph, and the telephone have ceased to be classed as wonders; and we face the last greatest discovery of the century, the application of which bears more directly upon our immediate interests than any other, namely, electricity as a motive power. . . . I see in the recent subjugation of the subtle and hitherto illusive force of electricity to the needs of man boundless possibilities for the world's three great requisites for advancement—heat, light, and motion. The crude experiments already made with electricity as a motive power in propelling cars, in lieu of steam or horse power, clearly foreshadow the inevitable application of the new motor to our immediate interests."

That meeting experienced a disappointment. It had on the agenda an entry of a paper to be read by Mr. Leo Daft, one of the first inventors in the field of electric traction, on the subject of "Electricity as a Motive Power." A telegram was received from Mr Leo Daft stating that "he had been too busy to prepare the paper." Thus in 1883, the first paper on the practical operation of "overhead" electric traction had yet to be written. Mr. Daft's brain was, we can readily believe, intensely occupied in solving the many intricate problems and overcoming the great difficulties which would present themselves to him at that early stage.

The Bristol Tramways Company was a pioneer in this country, first of horse tramways and next of electric traction on the overhead principle. It has, therefore, been an uphill fight to educate and to convert; and in doing this there has not been lacking an occasional passage of arms between the company and the local authorities. These little diversions are at least interesting to look back upon.

It was my good fortune to have served an early apprenticeship in Bristol under the able general managership of Mr. J. Clifton Robinson. It is with excusable pride that I refer to the fact that I have served under the distinguished rule of Sir George White, Bart., for a period of 30 years, since 1875; and for nearly as many years under that of his brother, Mr. Samuel White, both of whom have been closely identified with the Bristol Tramways Company from its inception and throughout those momentous years. Both of these gentlemen are widely known. The great work done by them in Bristol alone would have placed them in the front rank of electric tramway organisers, but the marks of their genius in this respect have been impressed upon many towns in this Kingdom. The London United Tramways, on account of the formidable obstacles of various kinds to be overcome, stand out prominently as a monument to their genius, tact, and enterprise. Associated with them, as is well known, in this great undertaking, is Mr. J. Clifton Robinson.

His Majesty the King was quick to recognise the valuable services rendered to this country by Sir George White, and conferred upon him a year ago a baronetcy. Sir George White and his brother already appear in the pages of the nineteenth century "Bristol Annals." When the twentieth century "Annals" come to be written, there is every indication that their names will occupy a prominent place on account of the princely manner in which they are perpetuating the undying traditions of Bristol in connection with her political institutions, her commerce, and, not least, her charities.

Bristol was the first to shorten the hours of labour of tramway employees. In the early days, on horse tramways, a man took out a car in the morning and brought in that same car at night. During the day he had tired out eight to ten horses, and I think we may safely say that in the process he had tired himself out. It was a case in those early days of long hours and small profits. The public had to be taught, by slow process I will admit, to give up the pernicious habit of walking and to improve their health and strength by riding. We promised them at that time speed and comfort. Now with electric traction we give them in comparison double speed and luxuriant comfort.

As soon as we had taught the Bristol public to use the cars freely (the citizens declare now that we have made them all too lazy to walk), and as soon as the company's financial position would admit the directors reduced the hours of labour of the employees to twelve a day; then followed eleven hours; then ten hours. Those concessions were made without any demand coming from the men. These concessions were followed from time to time by others. Paid-for holidays were instituted. An Employees' Provident Society was formed to which the company contribute an equal sum to that of the employees. Then doctors were appointed, and their fees as well as medicine are paid for entirely by the company. The last scheme, and one perhaps that is unique in connection with tramways in this country, was the introduction of a pension fund for the benefit of all employees.

Sir George White and Mr. Samuel White again showed their magnanimity and their unselfish solicitude for the men's welfare in making such a scheme possible by contributing personally, to form a nucleus, three thousand five hundred pounds. The company maintains the fund

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by annual contributions, and a special feature of it is that the employees are not called upon nor allowed to contribute anything. Old hands are now drawing pensions. Others are looking complacently forward to the time when, their labour being done at the age of 65, they will participate in it.

Electric tramways on the overhead system have been in successful operation here since 1895, now ten years. As you will readily believe, they have attracted to this city many deputations and individuals for the purpose of acquiring a knowledge of their construction and operation with a view to their introduction elsewhere. Bristol has, therefore, played an important part in influencing the choice and development of electric traction.

That very useful institution, "the stopping station," was first introduced in Bristol. I gave expression to my views regarding the subject in an article entitled "Fixed Stopping Stations on Tramways," in THE TRAMWAY AND RAILWAY WORLD, of December, 1896. As tramway managers we possess a community of interests, as our frequent communications one with the other indicate. Electric traction has been the means of introducing tramways into many new places, and consequently has added largely of late years to the list of managers. The excellent and alert tramways technical press makes us familiar with the new names, and keeps us acquainted with the progress of electric traction everywhere. The Association of which you are members gives all an opportunity to meet each other and thus to become, under pleasant circumstances, personally acquainted with each other. I wish you a pleasant and profitable time in Bristol during your very brief visit, and I feel sure that the heads of departments of my company will each do his best to bring about that happy consummation.

The PRESIDENT, in moving a vote of thanks to Mr. Challenger for his hearty welcome and interesting remarks, said he much regretted the sparseness of the attendance, but, unfortunately, their Association was largely composed of members residing in the North and Midlands, and he (the President) had a railway journey seven hours north of Bristol. At the same time he would like to add that it was hoped that this conference and visit would have been the means of inducing some of the members interested in the Southern and South Western tramways to visit Bristol.

Mr. CONATY (Birmingham) seconded the proposition, which was unanimously adopted.

The minutes of the previous meeting were read and confirmed.

The following were then elected members of the Association: Mr. Henry Burden Harris (Croydon Corporation Tramways), Mr. W. A. Davis (Wolverhampton District Tramways Company), and Mr. John Whyte (Birmingham and Midland Tramways Company).

On the motion of the PRESIDENT, seconded by Mr. TWEEDY, the report and statement of accounts for the year ended December 31, 1904, were adopted.

The PRESIDENT said a desire had been expressed that the three associations known as the Municipal Tramways Managers' Association, the Light Railways Managers' Association, and the Association of Tramways and Light Railway Officials, should amalgamate and form one united association. At a previous meeting a very strong request was put forward that a movement should be initiated for including the three existing associations in one large organisation. It was considered that such a step was highly desirable, and that an organisation on such a basis would be found to work satisfactorily. It would be better able to deal with matters affecting the Board of Trade, and would be able to pay more attention to tramway and light railway legislation. It was suggested that a meeting to discuss the proposition should be held and that each of the three associations interested should appoint a deputation of two to meet and consider the question of future amalgamation. Of course, the deputations could not pledge their associations to any definite step; the only thing they could do was to come back to the next meeting and report what they had done.

Mr. CONATY said the subject of amalgamation had been before them for some time now, and, in the opinion of a great many members, it was felt desirable that they should form one association with the object of obtaining a proper voice in regard to light railway and tramway matters which came before Parliament and the Board of Trade. If they could arrange terms for amalgamation it would be a step in the right direction. He moved that a deputation be appointed.

Mr. J. WARD, who seconded the motion, fully endorsed the remarks of Mr. Conaty, and thought the deputation should have full power to act.

The proposition was adopted, and it was also resolved that the President and Mr. Conaty should attend as a deputation.

The PRESIDENT announced that a letter had been received from the Tramways and Light Railways Exhibition Committee, inviting their presence and co-operation at the Electric Traction and Railway Exhibition at the Royal Agricultural Hall, London, from July 3 to 14.

It was decided to accept the invitation.

The following members were elected to serve upon the Executive Committee: Messrs. A. L. C. Fell (London), C. Conaty (Birmingham), A. R. Fearnley (Sheffield), H. Mozley (Burnley), A. H. Bannister (Norwich), H. Hartley (Darlaston), and R. W. Cramp (Birmingham).

It was resolved to hold the next Conference in London.

THE BRISTOL TRAMWAYS.

BY SYDNEY E. SMITH

(Assistant Traffic Manager of the Bristol Tramway Company).

Having been asked by your secretary to read a paper descriptive of the Bristol tramways system, I shall endeavour to place before you in as concise a manner as possible some interesting facts as to the equipment and working of the executive departments of the Bristol Tramways and Carriage Company, Limited. The names of the directors are so well known to such an assembly as this that I have only to mention them to bring to your minds the great part they have played in the introduction and development of electric traction in this country—Sir George White, Bart., chairman; his brother, Mr. Samuel White, managing director; Mr. J. Clifton Robinson, A.M.I.C.E., M.I.E.E., director and engineer to the company; and Mr. J. H. Howell, director. Mr. H. F. Cooper is the secretary of the company, and my brother, Mr. H. White Smith, is the accountant. Mr. George Matthews is the manager of the carriage department, but inasmuch as the work of this department does not come within the scope of my paper I shall not enlarge upon it.

The work of the company is carried on by five executive departments, under the direction of Mr. Samuel White, the managing director.

PERMANENT WAY AND BUILDINGS DEPARTMENT.

Mr. G. T. C. Edwards, who has been resident engineer to the company since 1893, prior to the introduction of electric traction, is responsible for the work of the permanent way and buildings department.

The route mileage of the system is 28½ miles, of which 23½ miles are double track and five miles single track. The rail bed is composed of Portland cement concrete, 6 in. thick, and extends for 18 in. on each side of the outer rails. The rails are of the girder type in 36 in. lengths, 6 in. deep, with 7 in. flange, and weigh 92½ lb. per yard. The joints as originally laid down were fished, mounted on sole plates, and secured by top strips. In any reconstruction anchor girders or chairs are used, and rails anchored at intervals of about 10 ft. Tiebars are fixed at about 6 ft. intervals. Two Columbia 0000 or Crown Bonds are provided at each joint, and the rails are cross-bonded on steep grades.

The points and crossings are generally of crucible cast steel, the points being 7 ft. 6 in. long with a 4 ft. 6 in. tongue, and the crossings of varying angles, but in most cases 1 in 8. Cut crossings were generally used in the construction of junctions. We are now adopting a point 12 ft. 6 in. in length with a manganese tongue for the movable points 9 ft. in length, thus having the tongue longer than the wheel-base of the cars. Manganese crossings will also be used.

Of the 28½ miles of route comprising the system, 12½ miles are paved with granite setts 4 in. by 5 in. by 9 in., and the remaining 16 miles with jarrah, karri, or beech wood blocks, except on steep gradients, where creosoted deal is laid down. There are many steep gradients throughout the system, the three steepest being 1 in 10 for a length of 187 ft. on Blackboy Hill, 1 in 10½ for 400 ft. on Redland Hill, and 1 in 11 for 120 ft. on Nag's Head Hill The radius of the sharpest curve in Bristol is 28 ft. 6 in., and there are a great number of curves with radii of less than 40 ft. The most interesting curve is at Colston Street. This curve has a uniform radius of 31 ft. on a steep gradient and forms an arc of 220 degs.

Rail corrugations, which have only made their appearance during the last two years after three years of rail wear, are causing considerable work in reconstruction. In some cases the distance between the crests of the corrugation waves is as much as 8 ins., and from the crest to the bottom of the hollowed portion ⅛ in. This trouble principally takes place on the outer rails of long flat curves. We are obtaining a machine fitted with carborundum wheels to grind out the corrugations in their early stages, as once set up their development is rapid.

In three cases the depth between the underside of railway bridges and the surface of the roadway is only 16 ft., giving a clearance of 8 in. from the top of the trolley standard on the cars.

The car depôts are six in number, and give the following accommodation:

Brislington ..	130 Cars.	Kingswood ..	30 Cars.
Horfield	60 ,,	St. George ..	20 ,,
Staple Hill ..	42 ,,	West Street ..	20 ,,

thus providing for the housing of 302 cars.

OUTSIDE ELECTRICAL DEPARTMENT.

This department is under the supervision of Mr. W. H. Munton, who is responsible for the erection and maintenance of the overhead work, the maintenance of the cable ways, and the lighting and power installations of depôts and offices.

In Bristol may be seen each of the three types of overhead construction, brackets in the narrow streets, span wires in most of our thoroughfares, and centre poles in the few broad streets we possess.

The trolley wire as originally erected was of hard drawn copper wire of 0 section (98 per cent. copper, Mathieson's standard) fitted

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with the ordinary type of sweated ears. On repairs becoming necessary we stopped sweating on the ears and simply tapped over the flanges, as we found that in the process of sweating the heat softened the trolley wire and weakened it at the point requiring the greatest strength. In renewing the original work and on routes with specially heavy traffic, we are replacing the 0 section wire by a wire of 8 section, and up to the present the results have well justified the extra expenditure upon this heavier section wire. Mr. Munton has designed a very satisfactory line of fittings for this section of wire, securing a smooth under-running path from end to end of the line.

Air-gap section insulators are placed about every half-mile, and the usual facilities are afforded at the junction boxes for cutting out or putting different sections into parallel

At termini we are using a special device for reversing the trolley arm without taking the trolley from the wire, thus giving the passengers a continuation of the light from the car, and materially reducing the time required by cars at each terminus.

All feeder pillars are fitted with telephones which are connected up to a central switchboard at the power-station.

At two of our central depôts we keep emergency tower wagons with a staff of wiremen in waiting. The wagons are equipped with the latest pattern harness similar to that used by fire brigades.

The best tribute that can be paid to the work of this department is that our cars run with the trolley ropes tied up throughout the day, and it is very rarely that trolleys leave the wire.

The bulk of our cables are paper insulated and lead covered, and are drawn into cement lined ducts which are laid in concrete along the routes. At intervals of about 400 yards manholes or inspection chambers are provided. During the five years this system has been in use only three feeder cables have broken down, in each case the breakdown being caused by electrolytic action.

Our workshops and car depôts are lighted with arc and incandescent lamps, current being supplied from the power-station at a pressure of 500 volts. All our workshop machinery is electrically driven.

Power-Station.

The power-station, which was built in 1900 to the plans and specifications of Mr. J. Clifton Robinson, engineer to the company, is in the charge of Mr. W. H. Dixon. It is conveniently situated in a central position, and is built with the whole length of its frontage on the harbour. The station is arranged in three storeys, the engine-room occupying the main floor, with the boiler-room immediately overhead, while over the boilers are the coal storage bunkers, economiser, and the boiler feed tanks. The basement contains the auxiliary plant. The building consists of a steel framework built in with brickwork and freestone facings. It measures 137 ft. long, by 53 ft. wide. The foundations of the building consist of 12 in. to 14 in. square piles placed about 3 ft. apart, centre to centre, upon which a steel grillage rests, binding a solid concrete bed.

The riverside position of the station enables coal to be delivered by colliers direct from South Wales. The main coal hopper consists of a steel cylinder with a capacity of about 500 tons, built on the wharf. This hopper is fitted with a grab hoist driven by a small high-pressure engine fixed on a platform at the top of the hopper. This grab descends into the boat lying below, raises the coal, and drops it into the main hopper. From here the coal is taken as required by a Hunt gravity bucket conveyor, and deposited where required in the coal storage bunkers at the top of the building over the boilers. These bunkers have an additional capacity of about 300 tons, making the total coal storage capacity 800 tons.

There are eight pairs of mechanical stokers driven by a 5-horse power motor from either end of the boilers. The ashes are taken from the furnaces through a trap in front of each of the boilers into the buckets of the conveyor, from which they are deposited automatically in the ash hopper, which is situated so that when a sufficient quantity has accumulated they may be shot into a barge at the wharf below.

The main flue to the chimney is directly over the boilers, and is made of steel plates with a lining of firebrick. The economiser is composed of 360 tubes in 36 sections.

The chimney stack is composed of two parts, one being a brick pedestal and the other the steel shell forming the shaft. The interior of the brick portion, however, is utilised for a spiral stairway leading from the engine-room to the boiler-room, where, at a height of about 60 ft., the flue joins the chimney shaft. The total height of the chimney from the ground level is 260 ft. The steel shell is made of plates varying from ⅜ in. thick at the bottom to ¼ in. at the top. It is lined with firebrick to a thickness varying from 9 in. at the bottom to 4½ ins. at the top. Eight 2¼ in. holding-down bolts pass down through the 60 ft. of brickwork and secure the shell.

Steam is generated in eight Babcock and Wilcox boilers. Each boiler contains 3,140 square feet of heating surface, and can evaporate 8,000 gallons of water per hour, the working pressure being 160 lb. per square inch. The three boiler feed pumps draw water from the two tanks over the boilers. Each of these tanks has a capacity of 6,000 gallons, and receives its supply from the hot-well in the basement. The steam passes from the boiler receivers into a header in the boiler-room, and thence through separators into the engine-room header. The main engines consist of four vertical cross-compound condensing sets of the Reynolds-Corliss type, of from 750 to 1,000-horse power each, and driving four continuous-current 500 KW. generators. The cylinders are 22 in. and 44 in. diameter by 42 in. stroke. The engines run at 90 revolutions per minute. The flywheels are 16 ft. in diameter and are built up of eight 5-ton segments. Two Bellis engines of 75-horse power each, driving a 50 KW. generator, are installed for lighting work after the main sets are shut down.

The condensing plant consists of two Wheeler surface condensers, each capable of using about 20,000 lb. of steam per hour. The air-pumps of 17½ in. diameter, are of the vertical twin type, each operated by two steam cylinders, 7½ in. diameter by 8 in. stroke. The circulating pumps are of the centrifugal type and draw and return their discharge from and to the harbour. The air-pumps discharge their water into the hot-well in the basement, from which it is lifted to the boiler feed tanks by pumps of the three-throw type. The wastage of water is supplied to the hot-well from the water company's mains through the water softener.

Four negative boosters of 30 KW. and one of 15 KW. capacity are provided to assist the return circuit from distant points of the system.

The switchboard consists of 6 generator panels, 1 Board of Trade panel, 5 negative booster panels, 3 lighting panels, and 21 feeder panels.

Traffic Department.

This department, which organises and operates the system of cars and keeps the rolling stock in a thorough state of repair, is managed by Mr. Chas. Challenger, who has been connected with the tramways of Bristol since the first horse-car traversed its streets so long ago as August, 1875. In 1900, on the introduction of electric traction and the extension of the system, I was appointed assistant to Mr. Challenger.

The rolling stock consists of 232 motor cars, together with 1 watering car, 2 snow ploughs, and 21 'buses.

The equipment of the motor cars is as follows: 151 cars are equipped with G.E. 58 motors and B 18 controllers, and are mounted on Peckham trucks; 31 cars are equipped with G.E. 800 motors and K 2 controllers, and also mounted on Peckham trucks; 20 cars are equipped with G.E. 52 motors and K 10 controllers, and mounted on Brill trucks; 30 cars are equipped with B 49 Westinghouse motors and No. 90 Westinghouse controllers, and mounted on McGuire trucks.

Three types of brakes are used in service, viz., the wheel brake, electric brake, and track brake. The wheel brake is of the usual rigging. The electric brake is of the rheostat type, and is used continually throughout the day for descending gradients and service stops. You will readily appreciate that the reluctance of many managers to use this brake in service is without reason when I tell you that during 1904 only eight armature coils required repair on the 180 cars on which this brake has been constantly in use for the past four years. To negotiate the many steep gradients of Bristol, cars are equipped with mechanical track brakes. The shoes are of ash wood, 20 in. in length, and plugged alternately with hard wood and resin and sand.

Trolley standards are of the enclosed spring type and are set on one side of the gangway on the top decks of cars. Trolley heads are of the swivelling type and the wheels made of phosphor bronze. Steel tyres are shrunk on to cast steel centres, and set screws are not found necessary to secure the tyres. The lifeguards in use are of the well-known Wilson and Bennett type, and since they were fixed to every car 2½ years ago we have had no fatal accident to record. A number of cars on each route are provided with efficient track cleaners which are lowered into the grooves of the rails two or three times a day for cleaning purposes.

Two circuits of five lamps in series provide lighting for the interiors, destination indicators, headlights, and platforms. Electric trembling bells are provided for use of passengers and are operated by push contacts within and on the top of all cars. The conductor signals to the driver by a mechanical single stroke bell.

Destination indicators, designed and patented by Mr. Challenger and myself, are fitted with translucent slides and display the names of the termini of the route and some well-known intermediate points. These slides do not require changing at the end of the trip. Spare slides of other routes are carried in a magazine in the indicator box. Inside seats are upholstered in moquette. Mr. Challenger's patent waterproof seats are used on the top decks.

Car Repair Shops.

The spacious depôt at Brislington contains paint shop, car-building shop, woodworking shop, bandmill, timber stores, fitting shop, armature room, and general stores, with accommodation for 60 cars under construction or repair. For the convenience of the works' staff a kitchen and dining-rooms have been provided and are much appreciated.

All motors are cleaned and breaks adjusted every night, and controllers are examined every night and thoroughly cleaned every other night. One motor cleaner is required to overhaul four cars per night. The cars are washed, brushed out, and all brasswork is cleaned every night. One washer is required to clean five cars per night.

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CAR SERVICES AND STAFF.

Sixteen different routes are traversed by the cars of the company: 7½ minutes is the greatest interval between cars on any route, and on the principal routes the intervals are from 2½ to 5 minutes. From 180 to 200 cars are run daily, while at holiday time the whole of the 230 cars are put into service.

A duty card is issued to the driver of every car, which shows to the half-minute in addition to his hours of duty his departure time from the termini on each trip, and the exact time he should pass some intermediate points on the route throughout the day.

Conductors pay their receipts in to the receiving office after the completion of two, three, or four journeys, according to the length of route, and are given an acknowledgment for every such payment.

Inspectors are in all cases promoted from driving, and are employed to supervise the running of cars to correct times, the method of driving and the proper issue of tickets, and to make frequent examination of time. Each inspector is given a course of training in the shops to enable him to carry out small repairs on the road.

Drivers are held responsible for keeping time and for the careful handling of their cars. Each driver on appointment is instructed at the depôt in the parts of a car, and after satisfying his examiner is placed with old hands on different routes and with different types of cars. After about a fortnight's tuition he is again examined and if found satisfactory is given a certificate and placed for one week's practice on a car, having complete charge of it, but with a regular driver at his side, for which week he is paid. We then consider him fit to take any car on any route of the system.

Youths are appointed as conductors at the age of 18-20 years, and take about a week to learn their duties. On reaching 22 years they become eligible for employment as drivers if otherwise suitable.

A ledger account is kept at the manager's office of the good and irregular conduct of each member of the staff, so that for each offence the employee is judged in the light of his past record.

Each regular inspector, driver, and conductor is given a complete outfit each year, including coat, vest, two pairs of trousers, two caps, and a great-coat. Each driver also receives in addition a cap-cover, pair of leggings, and waterproof coat. The spare staff are provided with caps and waterproof coats. Each employee of the Company is required to contribute to a Provident Society in proportion to his rate of pay. The Company contributes to the funds annually a sum equal to the total subscriptions of the members. The Company engages and pays the fees of two doctors who attend every day at the Company's surgery, and may be consulted free of charge by the employees, or, if too ill to attend, the sick are visited in their homes. Medicine is also provided free of cost. On reaching the age of 65 years each employee who has been 25 years in the service of the Company is entitled to retire on a pension at the rate of half his pay, that is, 50 per cent. of his wages at the date of his retirement, and for every complete period of five years' service over the minimum of 25 years the rate of pension is increased by 5 per cent. of such rate of wages. The employees do not contribute to the pension fund, which is provided entirely by the generosity of Sir George White, and the Managing Director, Mr. White, and the annual contributions of the Company.

Mr. BANISTER, in moving a vote of thanks to Mr. Smith for his interesting paper, referred to the question of the corrugation of rails, and remarked that he had been lately reading a letter in one of the engineering papers from a practical railway manager in India. This gentleman thought he had discovered the cause of the corrugation of rails, and he (the speaker) concluded from reading the letter that corrugation was believed to be caused by the rigidity of the road bed upon which the tramway rails were laid, as he had not in the course of his experience seen any corrugation in cases where the road bed was of a more elastic and yielding character. It must also be remembered that the material of which the rails were made had something to do with corrugation. He had never seen any signs of corrugation in rails made of iron alone.

Mr. TWEEDY seconded the motion.

Mr. CONATY congratulated Mr. Smith upon his paper, which contained many matters of interest. The pension fund was an excellent institution, and a step in the right direction, but it was on lines which he was afraid all tramway companies could not afford. His association were commencing a pension scheme, but in their case the men would be called upon to contribute, and all the necessary funds would not be found by the company.

The PRESIDENT, in the course of further reference to the subject of corrugation, mentioned that in Hull the rails were laid upon longitudinal timbers—and consequently possessed a good deal of elasticity yet in that town they were troubled considerably with corrugation. He should like to have some information as to the tension of the trolley wheel upon the wire in Bristol, and the mileage obtained.

Mr. TWEEDY dealt with the arrangement of switches in the junction pillars in relation to the overhead feeder wires. Referring to difficulties experienced in running overhead work, he mentioned that he had tried to substitute a larger section of trolley wire than that already erected, but had found great difficulties when using two gauges of wire upon the same system.

Mr. SMITH, in reply to Mr. England's remarks as to the difference of mileage obtained from trolley wheels upon his system and that obtained in Bristol, pointed out that the difference probably arose from the pressure exercised against the trolley wire. Mr. England had told them that in Wakefield the pressure was about 25 lb., while the practice in Bristol was to use a tension of only about 20 lb. He might point out that the last 5 lb. on the tension was the 5 lb. doing the damage.

The PRESIDENT said his experience had led him to conclude that the composition of the wire had a good deal to do with the life of the wheels.

Mr. SMITH remarked that his company had experimented with trolley wheels of a composition which enabled them to obtain a mileage of 10,000 miles, but it was discovered that such a mileage result must have been obtained at the expense of the life of the trolley wire. The present trolley wheel in use gave as much life as he cared to obtain, having regard to the life of the trolley wire. He agreed with Mr. Tweedy as to the difficulty of using two gauges of trolley wire. It was not only impossible to do so satisfactorily, but no advantage. As to the pension fund to which Mr. Conaty had referred, they had many men in their employ over 60 years of age, and who had nearly completed the 25 years' period of service which entitled them to a retirement pension. The Company regarded these men not as employees in an ordinary sense of the word, but as old friends who deserved some recognition of their whole-hearted service, and so the pension fund was provided.

Subsequently the members of the Conference were entertained at luncheon by the Bristol Tramways Company.

The toast of "The King" having been honoured,

The PRESIDENT proposed "Success to the Bristol Tramways and Carriage Company," coupling with the toast the name of Mr. Challenger, who briefly replied.

IRON AND STEEL INSTITUTE.

At the opening of the annual meeting of the Iron and Steel Institute in London on May 11, a motion congratulating Mr. Carnegie upon his two years of office was moved by Sir William Lloyd Wise and unanimously passed. Mr. Carnegie, the first man not a British subject, appointed president of the institute, in returning thanks, said that he had a great advantage over most Americans—he was born in Scotland. As he grew older, however, all the petty distinctions of nationalities passed into nothingness. He believed in his soul that English speaking men would never stand opposed to each other, but side by side. He hoped that they would in the future find not only Americans, but Germans and Swedes and men of other nationalities in order that the institute might become cosmopolitan.

The new President of the Institute (Mr. R. A. Hadfield, of Sheffield), after announcing a donation of £5,000 from Mr. Carnegie, delivered the presidential address. The Prophet Daniel's statement, "Iron breaketh in pieces, and subdueth all things," was, he said, as true to-day as when it was uttered. The three main arteries of modern progress the railway, the steamship, and the electric telegraph—would never have existed without the aid of metallurgy. But there were still many great and complicated problems in that field to be solved. Higher speeds, increased wear and tear, the outcome of modern requirements, demanded the consideration of the most complex questions, and he would ask, "Had they risen to the occasion?" Did they guard well the lives and safety of the people? The only possible way to make satisfactory progress was to combine the practical with the theoretical in the training of metallurgists. Rule of thumb methods no longer sufficed. He would like to take a striking instance of the world's indebtedness to the metallurgist. There were not far short of 100,000 railway locomotives in the world (43,000 in America alone), representing probably a value of £300,000,000 sterling. Every pound of material in their construction had to pass through the hands of the metallurgist, and the whole of the working, up to the finished form, had been done with machines the manufacture of which was the result of his labours. The important position occupied by the metallurgist was further shown by an estimate by Mulhall, who gave the world's output of industries at £12,340,000,000 to £14,000,000,000, out of which £604,000,000 were direct metallurgical products, of which the United Kingdom and United States of America produced £140,000,000 and £229,000,000 respectively.

RUGBY ENGINEERING SOCIETY. The Rugby Engineering Society paid a visit of inspection to the generating station of the London Underground Electric Railways Company, at Lot's Road, Chelsea, on May 20. Seventy-five of the members availed themselves of the opportunity granted through the courtesy of Mr. J. R. Chapman, general manager, of inspecting what is probably the largest generating station in the kingdom. The party travelled to London in special reserved saloon coaches, which were also attached to the train for the return journey. The whole of the station was thrown open for inspection, and the members of the party were allowed access to all parts of the installation, with the single exception of the switchboard, which was closed, due to the fact that it was in operation.

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THE VALTELLINA RAILWAY.

Operations and Tests.

By E. Cserhati.

The main railway in the north of Italy, generally known as the Valtellina line, was opened for regular service on July 10, 1904, and is now carried on by the Rete Adriatica. This railway company took over the whole plant erected by Ganz and Company, of Budapest, three months prior to the expiration of the period of guarantee. As the line had previously been worked regularly for 21 months, the experience of 2½ years allows of the different items of working cost to be stated fairly reliably. On the other hand thorough tests have been made by the engineers of the railway company in regard to the working efficiency and other important features of three-phase railway working. In the following will be given a brief summary of the experience and results.

Working Cost.

Expenses for staff and material for the Morbegno power plant, for the period from July 1, 1903, to June 31, 1904, amount to 21,553 lire. During this period 3,420,502 killowatt-hours have been generated. Direct expenses for generating a KW. hour therefore amount to 0·63 centesimi, *i.e.*, about 0·06d.

Expenses for staff and material incurred for maintaining and inspection of working conductors, poles and transformer stations, amount to 329 lire per kilometer of permanent line, *i.e.*, about 21·7 lire per mile.

Expenses for maintaining and revision of rolling stock, including electrical equipment and mechanical part, per locomotive or motor-car kilometer, amount to 4·36 centesimi, *i.e.*, about 0·66d. per locomotive or car-mile.

The total expenses for traction service, including lubricating and cleaning material as well as staff's salary, amount on the average per year for the period with but partly electrically-driven goods trains to 1·97 lire, and for the period with trains conveyed exclusively electrically to 1·71 lire per 1,000 ton-kilometers, *i.e.*, 2s. 6d. and 2s. 2d. per 1,000 ton-miles respectively.

The corresponding expenses on a steam traction line in Austria selected by way of comparison, owing to its representing conditions similar to the Valtellina Railway as regards curves and gradients, although with a 30 per cent. denser traffic, amounted to 4·20 lire per 1,000 ton-kilometers; hence the savings effected in traction expenses correspond in the first case to 3·98 per cent. interest on first cost or capital expenditure, and in the second case to 5·53 per cent. Besides the gratuitous lighting of all stations and motor-cars, as well as heating of the latter is assured.

Current Consumption Tests.

During the two years' operation of the Valtellina line thorough tests have been made as to current consumption and recuperation on levels and on gradients, as well as the energy consumed at starting the trains. These tests have been undertaken by the engineers of the Rete Adriatica, Messrs. Novi and Donati, under the co-operation and superintendence of Mr. Celeri, engineer to the Italian General Inspection Service. The results were published at the Congress of Italian electricians held at Bologna in 1904. The test results stated hereafter are taken from these publications.

As cited above 3,402,502 kilowatt-hours have been generated at the Morbegno power plant during a year. The number of ton-kilometers, including weight of locomotives and the electrical equipment of motor-cars, for the same period amounts to 76,845,265. Therefore the energy consumption per ton-kilometer amounted to 44·3 watt-hours measured at the distributing board of the power-station, equal to 71·4 watt-hours per ton-mile.

In these figures are included:

1. The energy required for the traction of trains.
2. All the losses arising from the distributing switchboard of the power-station to the wheel periphery of the rolling stock.
3. The current consumption for lighting all stations with 1,254 incandescent lamps of 16 c.p.
4. Current consumption for lighting and heating the motor cars and locomotives.
5. Consumption of accumulator charging stations equipped with two motor-dynamos, each of 21 KW. capacity on the continuous-current side.
6. Consumption of tool machinery at the workshop of Lecco.
7. Energy required for the shunting service.
8. Energy consumed during various tests made for the purpose of inspecting the electrical apparatus and equipment.

The above-mentioned figures showing the energy consumption of 44·3 watt-hours have been established by the engineers of the Rete Adriatica in thorough accordance with, but independently from, Ganz and Company, for any period of the service.

The net consumption per ton-kilometer has been established by means of a motor-car specially equipped for the purpose, being fitted out with ammeter and recording wattmeters for both overhead phases. The average of 20 tests showed a consumption of 31 watt-hours per ton-kilometer, *i.e.*, 50 watt-hours per ton-mile measured in the car. This figure quite agrees with the test results obtained by the staff of Ganz and Company.

These tests were extended with a view to establishing the net consumption in the power-station, the train used for the purpose having run during the night after the termination of the regular service. The current consumption per ton-kilometer amounted to 34·9 watt-hours and therefore the working efficiency of the system to 88 8 per cent.

In order duly to appreciate the importance of the figures quoted, it must be borne in mind that the profile of the Valtellina Railway is a very unfavourable one, the average gradient of the whole line as taken for both directions amounting to 2·5 per cent. That is, a train running through all sections in each direction, from one end to the other and returning to the starting point, must be lifted about 527·5 meters, which height corresponds to the mentioned average gradient, the length of the run being $2 \times 106{\cdot}5 = 213$ KM.

The section between Lecco and Colico on which the energy consumption tests were carried out shows an average gradient of 2·1 per cent.; hence the 31 watt-hours must be regarded as the specific consumption per ton-kilometer at a speed of 60 KM. = 37·2 miles at a continual gradient of 2·1 per cent, including starting.

For acceleration from rest to a speed of 60 KM., 95 watt-hours are required per ton weight; losses arising in the motor and rheostat amount to 6 watt-hours per ton-kilometer. Assuming an efficiency of 85 per cent for the motors, the motor losses amount to 4·6 watt-hours, so that there remain but 1·4 watt-hours for rheostat losses, *i.e.*, 4½ per cent. of the total specific consumption.

A 120 ton train consumes 13 watt-hours per ton-kilometer at a speed of 60 KM. while continually running on level track. A motor-car running singly requires 48 watt-hours per ton-kilometer, including starting energy. The large difference as compared with the 13 watt-hours for a 120 ton train is due to air resistance which is diminished in by far a smaller measure than the train weight.

It will be seen that in the light of economical considerations it does not appear to be advisable to replace heavy trains by numerous light trains or cars. Moreover, it is not justifiable to attach so much importance to rheostat losses arising at starting as often is done, as in fact these losses are very small compared to the whole energy consumption.

Recuperation of Energy.

It ie well known that alternating-current induction motors have the peculiarity of restoring energy to the line when running on down grades of a certain incline which varies according to traction resistance, while the speed is maintained constant in a practical sense.

The practical value of this peculiarity has very often been doubted. However, the respective tests not only proved the possibility of recuperation, but settled at the same time the quantity of energy which would be recuperated. On a section with a down grade of 20 per cent., with a 120-ton train and about 30 KM. speed, 28·2 watt-hours *i.e.*, about 80 per cent. of the energy has been recuperated which otherwise would have been lost in braking. The exceedingly favourable result in regard to energy consumption on the Valtellina line is due chiefly to this circumstance.

The question as to how to utilise the energy recuperated has likewise been often discussed. The simplest solution would evidently be to equip for electric traction not only the steep ramps of mountain lines, but also the adjoining level sections, in order to assure the utilisation of the return-current of descending trains.

The energy recuperation may be taken advantage of not only when trains run on down grades, but also when stopping, provided that the motors are designed for cascade working. In this case the speed will be reduced to a fraction of synchronous speed when switching over to cascade connection, and the energy which has been required for train acceleration from rest to full speed is partly given back by the moving train masses. The current recuperated in this way amounts to from 35 to 40 per cent. of the acceleration energy, and to about 10 per cent. of the total consumption.

This advantage becomes of the utmost importance in suburban railway service where heavy trains have to be started and stopped in relatively short distances. It has, for instance, been proved in a project worked out for the Vienna suburban lines, that, with a four step cascade connection, by means of one or two parallel working primary and two secondary motors connected in different combinations, more energy will be given back at stopping than the rheostat losses amounted to at starting.

The importance of these facts cannot be denied in the case of main railways when looking at the matter from an economical point of view, inasmuch as mixed and local trains must be stopped rather frequently from a high running speed. The acceleration of these trains represents an important part of the total energy required. With a simple cascade working, 35 to 40 per cent. of this energy as above

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mentioned may be saved; with four-step cascade connections even more.

In the case of hydro-electric power-stations the energy recuperation is so far of importance, as it allows of a line with denser traffic or greater length being worked from the same plant than would be the case without recuperation. With steam plants much saving is effected in working cost.

Energy Consumption as a Function of Gradients.

For a certain speed the energy consumption may be represented very simply as a function of the gradient. Assuming that the motors work with an efficiency of 100 per cent., the energy consumption per ton kilometer expressed in watt-hours will be:

$$s = c\,(w \pm i)$$

c being constant, w the resistance in level, and i the gradient represented in meters per kilometer. The upper sign is to be applied on up grades, the lower one on down grades. The equation represents two straight lines cutting the ordinate axis at the same point. Halving the sum of the ordinates we get the average current consumption at a total cycle of running in both directions with due regard to recuperation. The equation shows that, provided motors would work with an efficiency of 100 per cent., the average current consumption would be the same on inclined lines as on level ones.

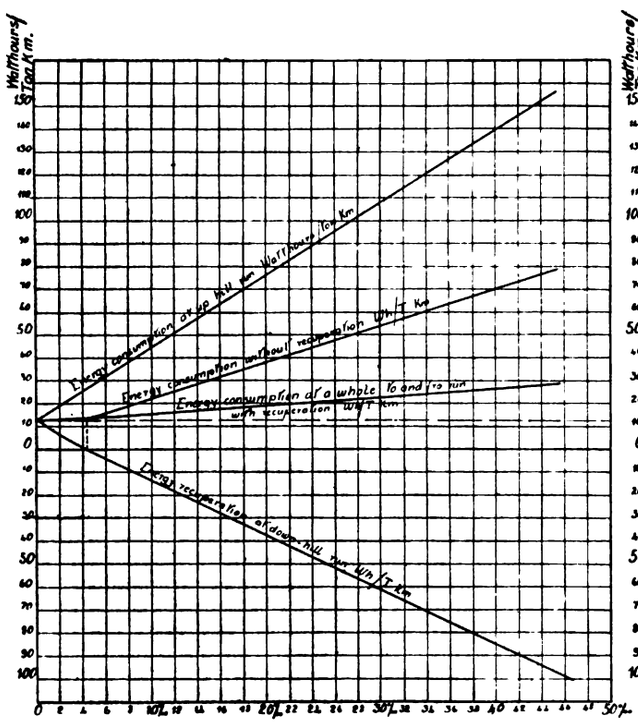

Fig. 1.—Speed, 31 km. (19·3 miles) per hour. Drawbar pull, 8,000 kg. Traction resistance, 4 kg. per ton.

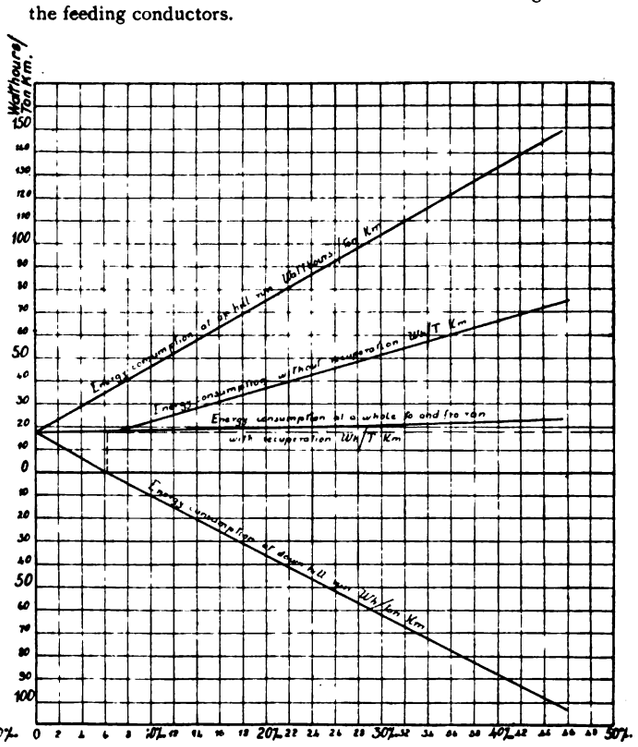

Fig. 2.—Speed, 62 km. (38·6 miles) per hour. Drawbar pull, 5,000 kg. Traction resistance, 6 kg. per ton

If we consider the motor efficiency which, as is well known, grows with the load, the current consumption up grades will be:

$$s_u = c.\frac{l}{\eta}\,(w + i)$$

and recuperation on down grades:

$$s_a = c.\,\eta\,(w - i)$$

By means of these quantities and the curves showing motor efficiency at different loads, the curves, Figs. 1 and 2, have been drawn; they show the current consumption and recuperation on down grades from 0 to 45 per cent., and for speeds ranging from 30 to 60 km. The half of the algebraic sum of ordinates represents also, in these cases, the actual consumption at a cycle up and down the hill. As will be seen, the consumption increases with growing gradients relatively slowly, especially at higher speeds, on account of the motor efficiency at single connection being higher than in cascade.

Where the curve cuts the abscissæ—when running down the hill—we get the down grade on which the train requires no energy for traction.

In Figs. 1 and 2 the curve has been drawn out which gives the energy consumption when the train descends without recuperation, no energy being required in the latter case; we therefore get the average consumption for a cycle by halving the ordinates for the run up grades.

From the above it will be clearly recognised how the economy increases with a system affording recuperation compared with one lacking that quality.

The difference in favour of the three-phase system allowing recuperation on down grades is as follows:

With gradients of	10 %	20 %	30 %	40 %	43 %*
At a speed of 30 km. ..	40 %	100 %	132 %	165 %	169 %
,, ,, 60 ,, ..	90 %	150 %	200 %	250 %	—

Fly-wheel Effect.

As will be seen by the watt-diagrams (Fig. 3) taken at the Morbegno power-station, the current rushes arising owing to the starting of even the heaviest trains do not represent higher peaks than about 70 to 80 per cent. of the energy requirements corresponding to the average consumption of the train just running on the line. This favourable circumstance is due in the first place to the use of water rheostats allowing of a smooth starting, so that passengers would not be able to notice the starting moment; accordingly no sudden current rushes can arise, while the current gradually increases. In the second place it is due to the peculiarity of induction motors to take no current from the line as soon as the periodicity is reduced by about 1 to 2 per cent.; if the latter is further diminished, then even current is given back to the feeding conductors.

When starting a heavy train, therefore, the number of revolutions of the generators and prime movers is reduced, and the periodicity diminished; consequently the short-circuited motors of the running trains will take no current so long as their speed drops to the value corresponding to the number of revolutions at the power plant. In this way the latter discharges at the current rushes. Should it happen that the number of revolutions of the generators be reduced suddenly by more than 2 per cent., current would be restored to the feeding line by the motors of all moving trains; that is to say, the totality of the moving train-masses would represent a huge flywheel having the effect of attenuating in a high measure the rush of current. This is an exceedingly valuable peculiarity of the three-phase traction system which should be duly appreciated, as up to the present time very little or almost no attention has been paid to it.

External Slip-rings.

On the latest type of the Valtellina locomotives the slip-rings are not arranged between the locomotive frames, but outside of them, as by this arrangement accessibility and supervision are facilitated, and the space inside the frame which would be required for the slip-rings is saved for the motor-body. It is therefore possible to fit in much more powerful motors than would be the case with slip-rings arranged inside.

This arrangement necessitates the passing of the three ends of the rotor-winding through the hollow crankshaft to the three slip-rings. There

* With such heavy gradients as represented by the last figures a speed of 60 km. has not been applied for the time being.

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is no difficulty in carrying out this arrangement with three conductors insulated from each other, whereas if the collector of a continuous or single-phase alternating-current motor were arranged in this way, more than 100 conductors would necessarily have to be brought out.

The possibility of thus equipping the locomotive with very powerful motors should be well appreciated, for the smaller the number of motors for a certain capacity, the less the weight, and the simpler the mechanical features of the electric locomotive. The three-phase motor is the only one that renders the utilization of the advantage possible.

ENERGY CONSUMPTION COMPARED WITH THAT OF OTHER SYSTEMS.

The current consumption per ton-kilometer is influenced by a great many circumstances, such as speed, gradient, curves, weight of train, distance between stations, etc. It is therefore difficult to compare the figures showing consumption of different railways equipped for different traction systems.

Moreover, very little information is to be found in the respective publications in regard to energy wanted on main railways or on lines with main railway traffic. Even this information applies to the consumption measured in the car, but not on the distribution board of the power plant.

The gross consumption of 44 watt-hours per ton-kilometer, which includes all losses and the consumption of all the electric apparatus on the Valtellina Railway, must be regarded as a very low one, as most of the figures known concerning other lines and representing the consumption in the car, are higher. Further, it must be considered that with direct-current lines the losses arising, from the distribution board of the power plant to the rotating transformer sub-stations, amounts to about 20 per cent.

On other systems a net consumption as low as 31 watt-hours (measured in the car) has never been reached before, and with a profile as low as that of the Valtellina Railway.

It is to be remembered, however, that the line has no gradients, except 2 per cent. on a 500 meter section.

In a project worked out by Ganz and Company, for the Vienna Suburban Railway, the watt-consumption of a train of the same weight at a maximum speed of 31 KM., and an average distance of 906 M. has been stated at 30·7 watt-hours, and the firm was prepared to guarantee that figure. In this case also the difference amounted to 45 per cent. in favour of the three-phase system, although on the Vienna line there are gradients up to 29 per cent.

According to a publication in the *Zeitschrift für Elektrotechnik*, No. 3, of 1905, the Stubaithal Railway requires 70 watt-hours per ton-kilometer. The corresponding energy consumption has been figured out on the basis of an exact profile of the above line for three-phase traction with the same speed as that given in the cited publication and without using cascade connection. For a complete cycle run in both directions with a train supposed to come back to the level of departure, an average consumption of 29·4 watt-hours pet ton-kilometer has been arrived at in the car, equal to about 31 watt-hours measured at the feeding point. This low figure is accounted for by the recuperation when trains run down the hill, which amounts to 27·6 watt-hours, whereas the consumption of a run up grades is 57 watt-hours per ton-kilometer.

The above figures relating to energy consumption on single-phase railways are taken from publications of the contracting firms; those relating to the three-phase system have been ascertained by official tests of the Rete Adriatica, or at least represent conclusions drawn from the latter.

The peculiarities of the three-phase traction system as discussed in the foregoing represent the following advantages: (1) The possibility of recuperating the energy stored up in the moving trains when the speed is being reduced at stopping, and the energy as represented by the train running on down grades; this energy reappears in the form

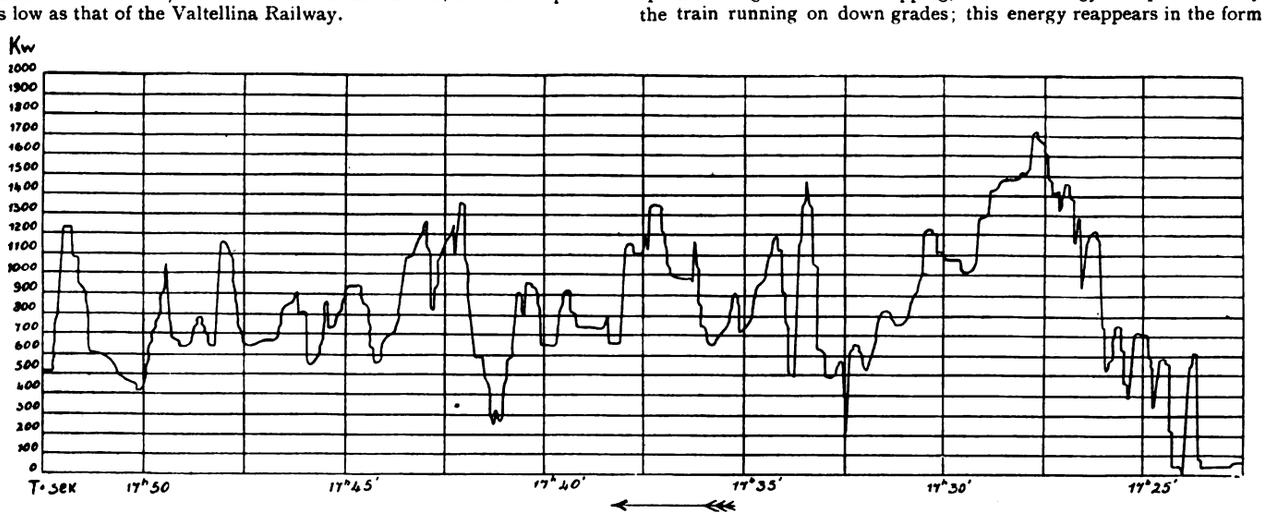

Fig. 3.—Wattmeter Reading at Power Plant.

Figures relating to consumption on direct-current lines do not offer any particular interest, as nobody is likely to think nowadays of equipping any line of great length with the direct-current system, as this system is more expensive both as regards first cost and working expenses. More attention should be paid to the respective figures of single-phase railways which, on the whole, offer the same advantages in regard to energy transmission on an extensive railway net-work, as the three-phase system. In August, 1904, there were published interesting results of tests carried out by the General Electric Company, on an experimental line equipped between Schenectady and Ballston. A test run has been made there with the same motors, the latter having been fed alternately with direct and single-phase alternating-current.

The record shows the following energy-consumption:

53·5 watt-hours for direct-current, and
78·1 watt-hours for single-phase alternating-current.

Hence 46 per cent. more current has been consumed by the same motor under identical conditions for single-phase alternating current, than for direct-current. No further evidence need be furnished that three-phase motors may be built with at least as high an efficiency as that of direct-current motors, and therefore conclusions may be drawn from the above test results as to the mutual behaviour in reference to energy consumption of three-phase and single-phase traction motors. The latter will require about 40 to 50 per cent. more energy than three-phase motors, provided that conditions are the same as those prevailing in the mentioned tests.

According to Glaser's Analen, 1904, No. 3, the Neiderschoneweide-Spindlersfeld monophase railway of 4·1 KM. length requires 45 watt-hours per ton-kilometer at a distance of 908 meters between stations, with a maximum speed of 34·4 KM. and with a train weight of 170 tons.

of electric current being equivalent to the greater part of the first. This circumstance results in a very low consumption. (2) To reduce by the fly-wheel effect the current rushes arising owing to the starting of trains. (3) The possibility to arrange the slip-rings apart from the motors, and thus to utilise the whole space available inside of the locomotive frame for placing the motors.

These advantages are obtained only by the use of induction motors, amongst the different types of which the three-phase motor alone has been found suitable for traction purposes.

Steam locomotives may run with any desired speed within certain limits, which are fixed by the capacity of the boiler and the security of service. The behaviour is similar with direct and single-phase current series motors, whereas polyphase motors will run but at a few determined speeds, according to the frequency, number of poles, and diameter of driving wheel.

This attribute of polyphase traction has at first been regarded as a drawback; now, however, the peculiarity in question is recognised as an advantage by experienced railway men. The chief condition of a regular traffic is exact observation of the time-table: all working systems allowing the staff to regulate the speed require a trained staff which, as it were, grow into living tachometers. Such experienced drivers will only do a safe service on lines with which they are well acquainted, and therefore their employment is limited.

The polyphase alternating-current traction system does not require such a thorough training of the drivers, owing to the speed remaining automatically constant without regulation after having reached a value peculiar to the system. Indeed, even on lines with a variable profile, the speed diagrams taken from actual service are almost horizontal lines. Thus, individual skill of the staff is nearly eliminated, being required only for correct starting and stopping.

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ANALYSES OF TRAMWAY REPORTS.

LIVERPOOL CORPORATION TRAMWAYS.

YEAR TO DECEMBER 31, 1904.

Horse system acquired, January, 1897.
Electric traction inaugurated, November, 1898.

	£	s.	d.
Borrowing powers	2,355,600	0	0
Loans outstanding	1,723,194	0	0
Sinking Fund	342,558	0	0
Amount withdrawn from Sinking Fund to meet Capital Expenditure	30,032	0	0
Reserve, Renewal, and Depreciation Funds	211,387	0	0

CAPITAL EXPENDITURE.

	£	s.	d.
Permanent way (including overhead equipment)	866,074	0	0
Land and buildings	166,727	0	0
Workshop tools and sundry plant	6,516	0	0
Cars	289,446	0	0
Other rolling stock	7,188	0	0
Parliamentary expenses	2,411	0	0
Preliminary expenses	72,633	0	0
Purchase of Liverpool tramway undertaking	485,006	0	0
Purchase of Garston tramway undertaking	20,257	0	0
Total	£1,916,258	0	0

Capital expenditure per mile of single track owned, £18,604.

REVENUE ACCOUNT.

INCOME.

	£	s.	d.	Av. per Car Mile d.
Traffic revenue	540,850	0	0	10·67
Advertising (cars)	6,260	0	0	·12
Miscellaneous	515	0	0	·01
	£547,625	0	0	10·80

EXPENDITURE.

Power Expenses.

	£	s.	d.	d.
Power expenses	94,937	0	11	1·87

Traffic Expenses.

	£	s.	d.	£	s.	d.	d.
Salaries and wages	121,204	18	1				
Cleaning and oiling cars	9,222	11	9				
Cleaning, salting, and sanding track	1,404	9	3				
Fuel, power, light, and water for depôts	2,508	12	1				
Ticket check	2,029	19	10				
Uniforms	4,374	0	3				
Miscellaneous	2,926	6	4				
				143,670	10	7	2·84

General Expenses.

	£	s.	d.	£	s.	d.	d.
Salaries	6,769	18	9				
Rents	1,381	18	1				
Rates and taxes	18,889	14	0				
Printing and stationery	1,644	14	6				
Fuel, light, and water for offices	627	7	10				
Accident insurance	11,441	7	2				
Other insurances	922	10	4				
City Fund	2,000	0	0				
Miscellaneous	3,165	16	0				
				46,843	6	8	·92

General Repairs and Maintenance.

	£	s.	d.	£	s.	d.	d.
Permanent way	25,119	4	1				
Electrical equipment of line	4,808	19	11				
Buildings and fixtures	1,799	0	11				
Workshop tools & sundry plant	1,322	8	4				
Cars	42,721	18	2				
Other rolling stock	720	11	1				
Miscellaneous equipment	44	9	1				
				76,536	11	7	1·51
Total				361,987	9	9	7·14
Balance carried to Net Revenue Account				185,637	5	0	3·66
			£	547,624	14	9	10·80

NET REVENUE ACCOUNT.

	£	s.	d	£	s.	d.
Balance from Revenue Account				185,637	5	0
Deduct—						
I. Rental of Bootle lines	5,857	11	5			
II. Interest	44,047	13	3			
III. Sinking Fund	54,969	9	7			
IV. Renewals and depreciation	53,653	15	9			
				158,528	10	0
Balance, being net surplus applied in relief of General Rate				**£27,108**	**15**	**0**

TRAFFIC STATISTICS.

Population served	770,000
Length of line operated (single track)	103 miles
Passengers carried	116,642,663
Car mileage	12,166,419
Passengers carried per car mile	9·59
Average fare per passenger	1·112d.
Average revenue per car mile	19·67d.
Operating expenses per passenger	·75d.
Percentage of operating expenses to total receipts	66
Board of trade units	20,045,629
Price per Board of Trade unit	1·159d.

BURNLEY CORPORATION TRAMWAYS.

FOR YEAR ENDING MARCH 31, 1905.

Electric traction inaugurated, December, 1901.

	£	s.	d.
Borrowing powers	210,255	0	0
Loans outstanding	181,623	0	0
Sinking Fund	12,835	0	0
Renewal Fund	7,932	0	0

CAPITAL EXPENDITURE.

	£	s.	d.
Purchasing of undertaking	38,448	11	11
Permanent way	65,123	17	0
Electrical equipment of line	13,098	8	2
Land and buildings	22,716	16	0
Cars	35,983	12	0
Other rolling stock	524	3	11
Offices and furniture	2,480	7	3
Engineering	1,152	18	8
Legal and parliamentary expenses	3,797	18	7
Preliminary Expenses	2,460	10	6
Total	£185,787	4	0

Capital expenditure per mile of single track, £13,270.

REVENUE ACCOUNT.

INCOME.

	£	s.	d.	Av. per Car Mile d.
Traffic revenue	53,497	17	6	10·467
Parcels	482	13	7	·095
Advertisements	46	2	6	·009
	£54,026	13	7	10·571

EXPENDITURE.

Power Expenses.

	£	s.	d.	d.	d.
Electrical power	15,449	0	9		3·022

Traffic Expenses.

	£	s.	d.	£	s.	d.	d.
Salaries and wages	10,486	10	1				
Cleaning and oiling cars	2,196	8	4				
Cleaning, salting, and sanding track	380	6	11				
Fuel, light, and water for depôts	261	15	7				
Ticket check	510	3	5				
Uniforms	322	7	9				
Miscellaneous	291	19	3				
				14,449	11	4	2·827

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General Expenses.

	£ s. d.	£ s. d.	d
Salaries	£1,002 12 7		
Rents	426 7 4		
Rates and taxes	1,613 12 10		
Printing and stationery ..	212 15 0		
Fuel, light, and water for offices	98 18 11		
Law expenses	131 9 3		
Accident insurance ..	677 4 4		
Fire and other Inces. ..	49 13 0		
Miscellaneous	161 19 4		
		4,374 12 7	·855

General Repairs and Maintenance.

Permanent way	£2,539 9 1		
Electrical equipment of line	274 5 1		
Buildings and fixtures ..	80 2 3		
Workshop tools and sundry plant	0 15 6		
Cars	3,326 1 2		
		6,229 13 1	1·219
Total		40,502 17 9	7·923
Balance carried to Net Revenue Account		13,523 15 10	2·648
		£ 54,026 13 7	10·571

NET REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Balance from Revenue Account ..		13,523 15 10
Deduct—		
I. Interest	5,564 18 0	
II. Sinking Fund	4,541 2 6	
III. Rents, etc.	2,235 10 7	
IV. Renewals Fund	1,182 4 9	
		13,523 15 10

TRAFFIC STATISTICS.

Population served	160,000
Length of line operated (single track)—owned	14 mls. 20 chs.
leased	5 mls. 32 chs.
Passengers carried	10,037,379
Car mileage	1,226,661
Passengers carried per car mile	8·18
Average fare per passenger	1·32d.
Average total revenue per car mile	10·57d.
Average traffic revenue per car mile	10·47d.
Operating expenses per passenger	·97d.
Percentage of operating expenses to total receipts ..	75
Board of Trade units	2,381,744
Price per Board of Trade unit	1·94d.

THE LONDON ELECTRIC POWER BILLS.

After sitting a great many weeks, the House of Lords Select Committee, presided over by Lord Camperdown, announced their decision on Thursday, May 18, respecting a number of the bills promoted with the object of obtaining powers to supply electricity in London and the surrounding district.

The CHAIRMAN stated that the Committee had decided with regard to the North Metropolitan Electric Power Supply Bill that that bill might proceed, but it was inexpedient that the Charing Cross and Strand Electric Supply Company Bill should proceed. It was inexpedient, also, that the City of London Electric Lighting Company's Bill should proceed. With regard to the Central Electric Supply Bill, they had decided that it was not expedient to grant the Company an area of supply, but otherwise the bill might proceed, although that did not mean that any particular clause would be passed without further consideration. With regard to the County of London Electric Supply Bill, the Committee had decided that it was inexpedient to pass those clauses which dealt with the linking up of the generating stations and the clauses dealing with the added area, or any extension; otherwise the bill might proceed. This left the Administrative County of London Bill and the Metropolitan Electric Supply Bill. The Committee had these bills still under consideration. While fully alive to the importance of providing a supply of cheap power, the Committee had not failed to appreciate that the introduction of a new power company not subject to statutory powers of purchase into an area already occupied by undertakers subject to such purchase powers must necessarily inflict some hardship on the latter; and before arriving at any decision on these two bills, the Committee would be prepared to consider any reasonable suggestion for obviating that hardship.

Mr. HUTCHINSON asked that the City of London Bill should be allowed to be presented in an amended form, dealing only with the supply of electricity to railway companies, and in bulk to authorised undertakers in adjoining areas.

Mr. BAGGALLAY, K.C., applied for the amendment of the Charing Cross and Strand Bill by the retention only of the clauses respecting the supply to railways, and giving statutory authority for the mains crossing the river by Waterloo and Charing Cross Bridges.

The Committee re-affirmed their decision that the bills should not proceed.

The clauses having been considered and amended, the North Metropolitan Electric Supply Bill and the County of London Electric Supply Bill were ordered, on the following day, to be reported to the House.

On Friday, May 19, the clauses of the Central Electric Supply Company's Bill were considered.

Mr. MOON, K.C., enquired, on behalf of the promoters, if the decision of the Committee not to allow powers to supply authorised users such as railways and tramways in St. Marylebone and St. Pancras extended to that part of Westminster in which the two affiliated Companies, St. James's and Westminster, had powers. The three Companies were practically one in purpose and interests, and they desired that within their area they should have power to supply to a consumer for use outside.

The CHAIRMAN said the Committee had decided so leave the position unaltered, and the bill, as amended, was ordered to be reported to the House.

On Monday, May 22,

The Administrative County of London Bill and the Metropolitan Electric Supply Bill came up for further consideration.

Mr. BALFOUR BROWNE, K.C., who represented the various companies in opposition to the Administrative County Bill, said his clients considered that there was no way to obviate the hardship that would be imposed upon them but by leaving out of the Administrative Bill those districts in which existing companies were under statutory powers of purchase.

Mr. FITZGERALD, K.C., for the Administrative County Bill, proposed the insertion of a new clause for the protection of authorised distributors. In this clause it would be provided that any application to the Board of Trade to determine whether consent had been unreasonably withheld should be accompanied by a statement of proposed prices. In determining whether consent had been unreasonably withheld, the Board of Trade would be required to have regard to all the circumstances of the case. He proposed a provision that the Board of Trade might impose such terms and conditions as might be necessary for the protection of the distributors, and for affording a supply of energy throughout an area. This gave the Board the widest powers as to conditions. Further provisions required the consent of the Board to any increase in price, and placed the Company under the same obligations to supply as authorised distributors. Lastly, the Board of Trade would be empowered to require the Company to lay suitable and sufficient distributing mains. The result of these amendments would be that the Board of Trade would have the widest possible powers to deal with the circumstances of each particular case, and would be specially called upon to consider the case of a company whose undertaking was purchaseable by a local authority at the expiration of 42 years.

As the result of considerable discussion,

The CHAIRMAN stated that so far as the point of hardship to purchaseable companies was concerned, the Committee had decided that when they came to the proper place they would insert a clause which in principle would be such as Mr. Fitzgerald had indicated. The Committee had decided that the two bills, the Administrative County and the Metropolitan, might proceed, and when the Committee reached the clauses dealing with areas, they would give to each Company an area. Speaking generally, this would assign to the Administrative County an area corresponding with that marked on the plan as "industrial," the eastern area. St. Pancras was in the Administrative, not the Metropolitan area, and they understood that there was no point at which the two areas would conflict.

Replying to Mr. Balfour Browne, the CHAIRMAN added that the Administrative Company would have the non-industrial or eastern area south of the river, and the Metropolitan Company the non-industrial area north of the river. In the Metropolitan Bill, a clause similar to that in the Administrative County Bill would be inserted.

On Tuesday, May 23, the clauses of the Administrative County Bill were considered and adjusted.

Among others, clauses were inserted providing that in deciding an appeal from the Company against unreasonable refusal on the part of authorised distributors to allow a supply of electrical energy within their area, the Board of Trade, in imposing conditions upon the Company, shall have regard to the fact that the undertaking of the distributors is purchaseable by the local authority, and a sub-clause was added providing that the Board of Trade may order that the power of the Company within the area shall cease should requirements not be complied with.

Another clause was amended with the effect of substituting ¾d. for 1d. as the standard price, and a clause was inserted protecting the Metropolitan Water Board in respect to their pipes against possible damage.

The bill was ordered to be reported to the House, as was also the Metropolitan Electric Supply Bill on the following day.

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THE ELECTRIC TRAMWAY AND RAILWAY EXHIBITION.

List of Exhibitors.

We append a list of firms who have secured space at the Electric Tramway and Railway Exhibition. The list numbers over 150, and includes most of the leading firms engaged in the tramway industry. Arrangements for the Exhibition are now well advanced, and exhibitors will be able to commence the fitting up of their stands on June 17. The Exhibition will be formally opened on Monday, July 3, by the Rt. Hon. the Earl of Derby, K.G. On the two following days the Municipal Tramways Association will hold its annual conference at the Exhibition and this will be followed by the meetings of other associations. Practically all the Corporations working tramways will be officially represented at the Exhibition by deputations.

148 A. B. C. Coupler, Limited, London, S.W.
87 Aiton and Company, London, N.W.
137 Alabaster, Gatehouse and Company, Limited, London, E.C.
77 Albion Clay Company, Limited, Burton-on-Trent.
118 Allen, Edgar and Company, Limited, Sheffield.
32 Ames-Crosta Sanitary Engineering Company, Nottingham.
138 Aron Electricity Meter, Limited, London, S.E.

13 Babcock and Wilcox, Limited, London, E.C.
119 Baker and Company, Limited, John, Rotherham.
94 Bayliss, Jones, and Bayliss, Limited, Wolverhampton.
88 Bennis and Company, Limited, E., Bolton.
21 Bentley and Company, Limited, Isaac, Salford.
112 Berger and Sons, Limited, London, N.E.
117 Bergish Steel Foundry, London, S.W.
142 Berliner Telephone Manufacturing Company, London, E.C.
17 Berry, Skinner and Company, London, E.C.
68 Blackwell and Company, Limited, R. W., London, E.C.
15 Blickensderfer Company, Limited, London, E.C.
142 Brawn and Company, London, S.W.
39 Brecknell, Munro and Rogers, Bristol.
8 British Electric Equipment Company, Limited, London, E.C.
78 British Griffin Company, Limited, London, E.C.
64 British Johns-Manville Company, Limited, London, E.C.
146 Brockie-Pell Arc Lamp, Limited, London, E.C.
103 Brookes, Limited, Halifax.
48 Bruce, Peebles, and Company, Limited, Edinburgh.
47 Brush Electrical Engineering Company, Limited, London, S.E.
158 Bullivant, W. R., Manchester.
91 Burton, Griffiths and Company, C. W., London, E.C.

34 Callender's Cable Construction Company, Limited, London, E.C.
85 Cambridge Scientific Instrument Company, Limited, Cambridge.
11 Chatwin, Thomas, Birmingham.
74 Churchill and Company, Limited, Chas., London, E.C.
134 Circulators, Limited, London, E.C.
75 Clarkson, Limited, Chelmsford.
152 Coe, W. H., Manufacturing Company, London, W.C.
38 Continuous Rail Joint Company of Great Britain, Limited, London, E.C.
102 Cowans, Limited, Salford.
122 Crossley Brothers, Limited, London, E.C.
80 Custodis Chimney Construction Company, London, S.W.

126 Dixon and Son, Limited, Leeds.
121 Dixon Crucible Company, Joseph, London, S.W.
151 Dolter Electric Traction, Limited, London, E.C.
92 Dorman and Smith, Salford.
71 Doulton and Company, Limited, London, S.E.
76 Durham, Churchill, and Company, Sheffield.

145 Edwards Air Pump Syndicate, Limited, London, E.C.
113 Electrical Power Storage Company, Limited, London, E.C.
96 Electrical Press, Limited, London, W.C.
45 Electric Tramway Equipment Company, Birmingham.
56 Elliott Brothers, London, S.E.
9 Empire Roller Bearings Company, Limited, London, S.W.
18 Everett, Edgcumbe, and Company, London, E.C.

3 Fastnut, Limited, London, E.C.
149 Fire-Resisting Corporation, Limited, London, S.W.
35 Fleming, Birkby, and Goodall, Limited, Halifax.
59 Forest City Electric Company, Manchester.
14 Foxcroft and Duncan, London, N.E.
79 Frankenburg and Sons, Limited, Salford.

12 Gawthorp, A. H., Leeds.
135 Glacier Anti-Friction Metal Company, Limited, London, E.C.
99 Glasgow Numerical Printing Company, Glasgow.
19 Graham, Morton, and Company, Limited, Leeds.
57 Green and Son, Limited, E., Manchester.
129 "Grey Royal" Granite Sett Company, London, E.C.
120 Griffiths and Company, Limited, Wm., London, E.C.

130 Haacke and Company, A., London, N.E.
61 Hadfield's Steel Foundry Company, Limited, Sheffield.
145 Haste Patent Pump Company, London, E.C.
66 Henley's Telegraph Works Company, Limited, W.T., London, E.C.
60 Holden and Brooke, Limited, London, E.C.
58 Howard Brothers, London, E.C.
155 Howard and Jones, London, E.C.
21A Hudson and Bowring, Limited, Manchester.
27 Hurst, Nelson, and Company.

54 Illingworth, Ingham, and Company, Leeds.
157 Isometric Lens Company, London, S.E.

40 Jones and Son, W.E., Bournemouth.

101 Kaye and Sons, Limited, J., Leeds.
41 Kelvin and James White, Limited, Glasgow
121A Knowles and Wollaston, London, S.W.

105 Lancashire Dynamo and Motor Company, Limited, Manchester.
95 Lassen and Hjort, London, E.C.
23 Laycock, Limited, W. S., Sheffield.
131 Le Carbone, London, E.C.
70 Library Bureau, Limited, London, N.
5 Library Supply Company, London, E.C.
93 Lorain Steel Company, London, E.C.
147 Lotery and Company, H., London, N.E.
132 Lubroleine Oil Company, Limited, London, E.C.

52 Mason, Limited, W. F., Manchester.
150 McEuen and Company, London, E.C.
20 McPhail and Simpson's Patents Company, Limited, Wakefield.
44 Meldrum Brothers, Limited, Manchester.
62 Mellowes and Company, Limited, Sheffield.
86 Mica Insulator Company, Limited, Walthamstow.
67 Millars' Karri and Jarrah Company, Limited, London, E.C.
69 Miller and Company, Limited, Edinburgh.
73 Milnes, Voss, and Company, Birkenhead.
49 Motor Car Emporium, Limited, London, W.
24 Mountain and Gibson, Bury.

43 Nalder Brothers and Thompson, Limited, London, E.C.
37 National Rail and Tramway Appliances Company, Limited, Liverpool.
133 New Expanding Metal Company, London, S.W.
123 Noakes and Sons, London, E.

98 Oliver Typewriter Company, Limited, London, E.C.

142A Page, John, and Company, London, E.
28 Pearse and Company, J. and B., London, W.C.
83 Pearson, Huggins, and Company, Limited, London, E.C.
115 Peters and Company, G. D., London, E.C.
12 Pfluger Accumulator Works, London, S.W.
125 Philipson and Company, Bolton
97 Player and Mitchell, Birmingham.
22 Pollock and Macnab, Limited, Bredbury, near Manchester.
141 Powell Wood-Process Syndicate, Limited, London, E.C.
139 Power-Saving Pulley Company, Manchester.
110 Proctor, Limited, Jas., Burnley.

32 Railway and General Engineering Company, Nottingham.
77A "Railway Times," London, W.C.
26 Raworth's Traction Patents, London, S.W.
109 Reavell and Company, Ipswich.
107 Recorders, Limited, London, E.C.
55 Richards, W. E., London, W.C.

111 St. Helens Cable Company, Limited, Warrington.
90 Scott, Stirling, and Company, Limited, London, W.C.
127 Shannon, Limited, London, E.C.
108 Simplex Steel Conduit Company, Limited, London, W.C.
89 Société Francaise des Accumulators, Paris.
16 Spagnoletti and Company, J. A., London, W.
42 Standard Varnish Works, London, E.C.
10 Statter and Company, Birmingham.
124 Stern-Sonneborn Oil Company, London, E.C.
30 Still and Company, W. M., London, E.C.
2 Stirling Boiler Company, Limited, London, S.W.
156 Straker and Squire, London, E.C.
81 Sturtevant Engineering Company, London, E.C.

144 Thermit, Limited, London, E.C.
50 Traction Corporation, Limited, London, S.W.
84 Trading and Manufacturing Company, Limited, London, E.C.
72 "Tramway and Railway World," London, W.C.
106 Triumph Stoker, Limited, London, S.W.

136 Underfeed Stoker Company, Limited, London, E.C.
140 Union Electric Company, Limited, London, E.C.

36 Vacuum Oil Company, Limited, London, W.C.

153 Walker and Throp, Halifax.
63 Wallace Supply Company, London, S.W.
6 Wallach Brothers, London, E.C.
51 Wathen, Gardiner, and Company, Bristol.
31 Western Electric Company, London, E.
46 Whiting and Sons, Limited, London, E.C.
38 Winby and Company, London, E.C.
100 Winn and Company, Chas., Birmingham.
116 Wolseley Tool and Motor Car Company, Birmingham.

114 Yates and Company, John, Birmingham.
128 Young and Company, Robert, Glasgow.

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TRADE PUBLICATIONS.

THE GENERAL ELECTRIC COMPANY, LIMITED, of 71, Queen Victoria Street, whose works are at Witton, Birmingham, have issued the 11th edition of their "P" section. In this their "Witton" continuous-current motors are fully described and illustrated: they include open protected, semi-enclosed, enclosed ventilated, and totally enclosed types. Prices, code numbers, etc., are given in every instance.

THE UNION ELECTRIC COMPANY, LIMITED, 151, Queen Victoria Street, London, E.C., has just issued their list No. VI. Since the first edition of this list, some 2½ years ago, several new designs have been added, and the very successful oil-break type of switch having been extended, the latest improvements are illustrated. Some wiring diagrams for their high-tension switches, with automatic release, and some of the arrangements of high-tension switchboards as carried out by the firm, will be found both useful and instructive.

MESSRS. J. BUTLER AND COMPANY, Victoria Works, Halifax, in the preface to the fifth edition of their general catalogue, point out the great changes that have taken place since their last edition was published ten years ago. The firm was established in 1868, but it has marched with the times, as a glance at the illustrations on each of the 174 pages clearly proves. In the period mentioned Messrs. Butler have more than doubled the size of their works, in which over 160 machine tools are in constant use. They make machines of all kinds, not only for manufacturers using high-speed cutting steel, but also for repairing shops in which such luxuries are not required, and for the foreign and colonial trade. They have aimed at making their catalogue and their supplementary price list a complete book of reference. Their direct electrically-driven machine tools are enumerated in a sectional catalogue. The firm also undertakes the making of special machines or mechanism, and "employ only one quality of workmanship, and that the very best."

ENGINE CATALOGUE.—Messrs. Mather and Platt, Limited, have five departments in their well-known factories. At the Salford Iron Works, in Manchester, are the electrical, engine, hydraulic, and textile departments, and the fire department is at the Park Works in the same town. Their London Office is at Queen Anne's Chambers, Westminster, S.W. A catalogue issued lately by the firm describes and illustrates their open type compound engines, with weights, dimensions and prices, with maximum loads of 40 to 440 KW.; their standard vertical independent engines of I.H.P. from 70 to 750; their horizontal engines from 10 to 300 I.H.P.; their combined enclosed high-speed engines, driving dynamos, pumps, etc.; also some auxiliary machinery, such as ejector condensers, suitable for engines from 5 to 4,000 I.H.P; first condensers and air pumps; surface condensers and Edwards' air pump in units up to 6,000 I.H.P. capacity. Finally, there are evaporating condensers and cooling towers, of which particulars can be had on application. A little half-tone illustration shows a power-house of about 10,000 I.H.P. capacity, and Messrs. Mather and Platt are justifiably proud when they can point out that they have built engines which work continuously for periods of seven months without a single stop day and night, at 25 per cent. above the output for which they were designed; and that in one station of 10,000 H.P. in combined steam dynamos, the average cost of power, delivered at the switchboard, is just ½d. per KW. hour.

"ROYAL EDISWAN" LAMP AND OTHER CATALOGUES.—We have received from the Edison and Swan United Electric Light Company, Limited, three new catalogue sections, namely: Section I., "Royal Ediswan" lamps; Section IV., measuring instruments; and Section V., wires and cables. Section I. contains all the latest forms of "Royal Ediswan" lamps, and embraces low and high voltage standard lamps, high candle-power lamps, "Queen" reflector lamps, obscured, tubular, crinkled, and olive lamps, "Royal Ediswan" traction and ship lamps, etc. A good deal of useful information is also set forth at the commencement. The blocks are specially well produced, and give a very clearly defined respresentation of the lamps. The whole is bound in a cover bearing the now well-known Britannia and Lion design, lithographed in Royal purple. Section IV. deals with measuring instruments of all sorts; a large number of pages are devoted to the "Ediswan" gravity, and moving coil instruments, and these are listed in a large number of sizes and varieties. Special attention is drawn to the "Ediswan" separate shunts for ammeters, which are claimed to be the best of their kind, being made without any soldered joints, and thus avoiding all thermo-electric and contact E.M.F. effects. Cardew voltmeters, which were originally made by the company, are listed in many varieties. Section V. is devoted entirely to wires and cables which are listed in large variety, in vulcanized and pure rubber, lead covered, armoured, concentric, and many other patterns. Flexible cords receive special attention, including flexibles for dynamos and switchboards, motor cars, etc., and some very useful pages are added for fuse, binding, and resistance wires. The introduction comprises some useful information on joint making, a table for calculating fall of potential, and a wiring table for "Royal Ediswan" lamps. These sections should be in the hands of every buyer for the coming season.

CENTRIFUGAL PUMPS.—Catalogue W. 50, issued by Henry B. Worthington, gives a valuable mass of information in a concrete form. In its 48 8vo. pages there are photographs of no less than 32 models of pumps, while on the frontispiece is a view of the works at Harrison, N.J., which cover 18 acres of ground and accommodate 5,000 men. There are other works at Brooklyn and Elizabethport, in the States, and at Newark, on this side of the Atlantic. The general offices are at 153, Queen Victoria Street, and those of the sales department are in New York. There are twelve branch offices in the States, including one in Honolulu, six in the United Kingdom, and others at Amsterdam, St. Petersburg, Copenhagen, Calcutta, Johannesburg, and Sydney, besides seven on the continent where the company takes on foreign names. In a short historical sketch the rise of centrifugals from the times of Papin, through the Massachusetts pumps, those of Gwynne and Appold, to the present highly developed article. In the Hyde Park Exhibition of 1851, some men still living will remember the sensation caused by Appold's cascade, which was a child's squirt when compared with the three 36 in. turbine pumps now delivering 35,000 gallons per minute, under a 160 ft. head, at the St. Louis Exposition. The Worthington pumps are adapted to all sorts and conditions of water, clear, turbid, acid, and alkali, and surcharged with solid material. Appold's pump delivered with a head of 20 ft. at the most; the Worthington work to 2,000 ft. head, and are of all sizes down to 2 in., being driven by all types of motors. The efficiency of the pump depends entirely upon its design, in fact it is possible by properly proportioning the several parts to build a pump having almost any desired characteristics and fitted for any special requirements of service. The pumps are divided into three main classes, viz.: conoidal, for load lifts and large deliveries up to 30 ft.; volsets, for medium lifts, but for all capacities, from 70 to 150 ft.; and the turbine pumps for very high lifts even exceeding 2,000 ft.

PROCEEDINGS UNDER THE LIGHT RAILWAYS ACT.

In the familiar form of a Parliamentary paper a report has been issued by the Light Railway Commissioners of their proceedings up to December 31 last; also a report of the proceedings of the Board of Trade, under the above-mentioned Act, up to the same date.

The latter report states that 12 out of the 15 Orders before the Board of Trade for confirmation on December 31, 1903, were confirmed during 1904, the County of Hertford, Waltham Cross and Enfield, and the Dover, St. Margaret's, and Martin Hill Orders being held over. During 1904 twenty fresh Orders were submitted to the Board by the Light Railway Commissioners, of which 14 had been confirmed. Confirmation, it should be noted, was not refused in any case, but in that of the Southend and Colchester Order powers were not granted in respect of certain proposed piers and ferries, and before the Order was confirmed an undertaking was required from the promoters that they should apply to Parliament for authority to carry out the omitted works. During 1904 twenty-one Orders were confirmed, comprising 97 miles, at an estimated expenditure of £801,352. Since the commencement of the Act, in 1896, 237 Orders have been confirmed by the Board of Trade, aggregating 97 miles, at an estimated outlay of no less than £11,279,780. Since the date of the last report the Treasury have conditionally agreed to make a further advance of £5,700 by way of loan at 3½ per cent. in respect of the Welshpool and Llanfair Light Railway. Appended to the present report is the additional rule, dated May, 1094, made by the Board of Trade with respect to the notices to be given and deposits made in cases where alterations of work are proposed during progress of application.

The report of the Light Railway Commissioners states that a total of 485 applications for Orders to authorise light railways (which includes applications for amending Orders), have been made since the commencement of this Act. In respect of 278 applications (21 in the year 1904, and 257 in previous years) Orders have been submitted to the Board of Trade; nine other applications, in respect of which Orders are under settlement, have been approved by the Commissioners, and 176 applications have been rejected or withdrawn. The decisions with respect to four applications have been deferred and eighteen new applications, made in November last, remain to be considered. Some highly interesting tables are appended to the report. Up to December 31 last application for lines on lands acquired, mostly steam motive power, totalled according to the engineer's estimate £14,276,689. Of this amount applications up to £6,883,980 were approved; £4,093,946 rejected; £1,453,710 withdrawn, and applications for £6,503,208 were sent to the Board of Trade.

During the same period applications for lines on public roads, mostly electric motive power, totalled £18,058,644, of which £5,661,643 worth were approved and £5,856,289 rejected, the Board of Trade dealing with applications aggregating £5,617,002. Amending Orders up to the end of last year reached £33,542,914, £13,039,261 being approved and £9,950,235 rejected, whilst proposals amounting to £12,535,348 were sent to the Board of Trade.

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LONDON COUNTY COUNCIL TRAMWAY MATTERS.

The Electrification of the Northern Tramways.

On May 16 the London County Council resumed their sittings after the Easter recess, and the postponed report (published in our issue of May 4) by the Highways Committee, proposing to acquire the remaining interest of the North Metropolitan Tramways Company in the lines worked by them on lease, and to proceed immediately with the conversion of these Northern lines for electric traction, was again submitted. Together with it was a report by the Finance Committee upon the whole proposals. The Finance Committee submitted the two estimates of expenditure of £121,000 for the purchase from the Company of leasehold properties and payment for the surrender of the lease, and £315,000 for the purchase of the horses, rolling stock, and other plant. The unexpired portion of the lease is 4½ years. The Finance Committee stated that they were disposed to agree with the Highways Committee that if the electrification of the Northern lines was to be proceeded with, the Council should have the lines in its own possession. The reasons against incurring further capital outlay were not so strong when that outlay was on a remunerative service, involving, the Committee hoped, no addition to the ratepayers' burden; and if the Council should deem it desirable that the electrification should be proceeded with, the Committee were of opinion that the course which the Highways Committee proposed was the right one, and they further agreed that the reconstruction should be carried out as quickly as possible.

The adoption of the proposals would commit the Council to the immediate electrification of the whole of the Northern system. No detailed estimates of the cost had yet been prepared, but the approximate figures were as follows:

	£
Reconstruction, including alterations to bridges, both under and over the road, removal of pipes, etc., and construction of authorised extensions—half for conduit system and half overhead	2,906,120
Setting back kerbs, etc.	15,208
Extra cost, if the whole is to be laid for conduit system... ...	470,000
	3,391,328
Total estimated cost of street widenings, if restricted to those which are considered essential to the maintenance of proper tramway services	945,275
	£4,336,603

The total expenditure involved, including the two estimates already submitted, was therefore about £4,773,000, which, however, might be reduced by £470,000 if half the lines were reconstructed for overhead instead of for conduit traction. To these figures must be added the estimated cost of the second portion of the Greenwich generating station, which might be taken at about £400,000, making a total outlay in round figures of £5,200,000. The expenditure would take place chiefly from 1906-7 to 1909-10 at the rate of about £1,500,000 per annum. The date proposed for the surrender of the lease—viz., April 1st, 1906, would afford time for all preliminary steps to be taken for the reconstruction of the first section (about 22 miles single track) with car-sheds and sub-stations, by about Christmas, 1906. The first half of the Greenwich station was to be ready by spring or early summer of 1906. The second section to be put in hand comprised about 46 miles single track, and this could be completed by about Midsummer or Michaelmas, 1908; and the third section, about 40 miles of single track, would be completed between Midsummer and Christmas, 1909. It was calculated that by the time the second section was complete, the second part of the generating station could be got ready to supply the power required. The periods during which the Council would have to work the lines by horse traction after purchase would be—First section, about nine months during reconstruction; second section, about 2½ years; 1½ years before, and 1 year during reconstruction; third section, about 3½ years; 2½ years before and 1 year during reconstruction. The loss to be sustained during reconstruction might be at least £1,000 per mile of single line, or a total of about £100,000, meaning about £30,000 per year.

It appeared that the traffic receipts were estimated by the Highways Committee at 1s. per car mile, and working expenses, including capital and renewal charges on the power-station, at 7d. per car mile. Out of the profit, a considerable sum would have to be set aside for renewal of track, cars, equipment, sub-stations, cables, etc., the balance would be available to meet the capital charges on the old horse traction debt and the new debt other than power-station. The value of the estimates depended principally upon the realisation of the figures of 1s. and 7d. respectively. The Southern electric system had working expenses of about 8d. per car mile, but when the Greenwich station was opened, it was anticipated that these would be reduced to 7d. The traffic on the Northern tramways when reconstructed was estimated at 21,024,000 car miles per annum, on the assumption that 640 cars would run on the average 90 miles per day. On this basis, the figures worked out at:

		£
Estimated receipts	21,024,000 miles at 1s. ...	1,051,200
Estimated working expenses ...	" " 7d. ...	613,200
		£438,000

These were large figures, and any alteration in the relation of receipts and working expenses would seriously affect the results.

The surplus on working had to provide for renewal of track, cars, equipment, etc., and for interest and repayment charges on capital outlay. As regarded the provision for renewals, large sums would undoubtedly have to be spent, and the Committee thought that on the present calculations an allowance should be made of 1d per car mile, and that the question would require to be gone into carefully again in the course of four or five years, when the system was in full working order. The interest and repayment charges in respect of the existing horse debt of the Northern system would be about £36,000, and in respect of additional outlay on reconstruction, assuming one-half of the lines to be constructed for conduit and one-half for overhead, about £216,300, a total of £252,500. If, however, the conduit system was to be adopted throughout, the debt charges would be increased by £35,250, making a total of £287,750. These figures did not include anything for the cost of street widenings. The repayment charges were based on 60 years for car shed and sub-station buildings and 25 years for the reconstruction works, cables, cars, and sub-station machinery. The charge for interest had been calculated at 3½ per cent. The estimated financial results when the work of reconstruction had been completed might therefore be summarised as follows:

	£
Estimated surplus on working	438,000
Provision for renewals, at 1d. per car mile	87,600
	£350,400
Interest and repayment charges	287,750
Surplus	62,650

Further charges against the surplus would include:

Any proportion of the annual debt charges for street widenings which the Council might decide should be borne by the tramways account; on the basis hitherto adopted of charging the account with one-third, the annual sum would be	16,400
Increasing the renewals provision to 1½d. per car mile after the first few years	43,800
	£60,200

The estimated result could not be considered as anything but a very narrow margin. The debt charges, however, would diminish every year by about £5,000.

In considering the financial results during the period of reconstruction, the Committee stated that it was doubtful whether the deficiency on the Northern lines during that time could be met without suspending the provision which ought properly to be made for renewals reserve on the Southern lines.

In reference to the price to be paid to the company for the surrender of the lease, the Committee thought the Council would on the whole be justified in confirming the terms of settlement. The £315,000 might fairly be spread over 25 years. As soon as electric working was in operation, provision should be made out of profits for more speedy repayment of all outstanding debt, representing dead capital for rolling-stock, rails, etc., no longer in use. The sum under this heading outstanding on March 31 next year would be £717,591. In regard to the estimate of £121,000, there could be no objection to spreading the £400,000 for leasehold properties and the £1,000 for costs over 25 years; but in regard to the £80,000 for compensation and good-will, this should be paid off in eight years.

The Committee finally presented a summary of their conclusions, in which they stated that during the period of transition the deficiency might be expected to be met, without recourse to the County rate, out of the surplus balance from the Southern system; but to accomplish this, it would be necessary to arrest the provision of an adequate reserve fund. The total capital outlay on the Northern lines, allowing for sale of horses, might be expected to reach about £4,500,000. This was in addition to expenditure for the completion of the generating station and the electrification of further lines already approved on the south and in the west of (say) £3,500,000. The tramway debt on December. 31, 1904, was about £3,500,000. Adding to this the balance of votes already passed and the further expenditure in contemplation, the total expenditure of the Council on tramways when all this outlay was complete might be put at between £11,000,000 and £12,000,000, without reckoning the cost of street widenings, which was charged to the street improvement account, and the annual charges on which would fall on the County rate. There were various factors in the solution of the traffic problem of London, the operation of which it would be impossible to foresee, but which must have a bearing on the financial results of the Council's tramways. These were the tube railways now in course of construction, the probable electrification of suburban railways, and

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the newly-arrived motor omnibuses. These considerations, having regard to the comparatively small margin of surplus shown by the foregoing estimates, appeared to the Committee to point to the necessity for the strictest economy in capital expenditure, and the exercise of caution in dealing with proposals to lower fares or to increase the cost of working the service.

Tramways in Archway Road.

The Highways Committee in reference to the construction of the tramways on the overhead wire system in Archway Road, Highgate, recommended that the offer of the Metropolitan Electric Tramways, Limited, to provide and erect the overhead equipment at the cost for labour and material, with an additional 10 per cent. for establishment charges, and in any case for a sum not exceeding £600, be accepted. The Committee also reported that they had examined tenders received for the construction of these tramways, and they were as follows:

	Tramway Construction.	Paving of Street Widening.	Total.
	£ s. d.	£ s. d.	£ s. d.
Dick, Kerr & Co., Ltd., London	4,587 15 9	1,010 8 5	5,598 4 2
D. R. Paterson, London	4,807 4 2	1,036 11 9	5,844 5 11
John Mowlem & Co., Ltd., London ...	4,920 2 4	1,035 8 7	5,955 10 11
Wm. Griffiths & Co., Ltd., London ...	4,254 13 8	1,034 5 10	5,988 19 6
R. W. Blackwell & Co., Ltd., London ...	5,037 15 8	1,104 18 6	6,142 14 2
Muirhead, Greig, & Matthews, London..	5,704 14 0	1,082 1 7	6,156 15 7

The Committee were of opinion that the lowest tender, that of Dick, Kerr and Company, should be accepted. They also proposed that the contractors be allowed to sublet to the Hadfield Steel Foundry Company the manufacture of the special work, to the Associated Portland Cement Manufacturers the supply of cement, and to Bayliss, Jones and Bayliss the manufacture of the tie-bars.

New Watering Cars.

The Highways Committee recommended that an expenditure not exceeding £2,500 be sanctioned for the purchase of four electrically-driven watering carts for use on the tramways. At present they stated they had only one watering cart, and it was not capable of doing all the work required. The Committee proposed to obtain the cars from a selected firm.

All the tramway reports were adopted with the exception of an adjourned report of the Highways Committee, with regard to construction of tramways in Archway Road, and leasing them for three years to the Metropolitan Electric Tramways, Limited.

A long debate took place with regard to the electrification of the Northern system and the purchase of the remainder of the lease and the plant and stock of the North Metropolitan Tramways Company.

Discussion on the Northern Proposals.

Mr. J. Allen Baker (Chairman of the Committee), in moving the reception of the report, said that although the proposals were far-reaching and of great magnitude, he had every confidence in submitting them, because their experience in the South fully justified the course recommended. He pointed out that as a result of electrification in the South, the receipts were steadily increasing. Last financial year the net receipts were £47,000 above estimate, and when they saved 1d. per unit upon the current by obtaining it from their own generating station at Greenwich, there would be a still further enhanced profit. Taking all items into consideration, he contended that last year the profits on the South reached £96,783, and if they had been able to get enough power to run all their cars instead of only 300 out of 400, the net earnings would have still further increased. Referring to the North Metropolitan lease, he pointed out that the receipts under that lease were steadily diminishing owing to the company having sold their lines outside the county, upon which 12½ per cent. on the increase on gross receipts were received, as well as upon lines inside the county. Only £500 was expected from this source next year, so that the lease was now of much less value. The estimates for the new year were most encouraging, while already the estimated receipts had been exceeded in the South in one week by £1,500, and in another by £2,000; the fact was the Council's trams were becoming more popular, were being worked with greater economy and skill, and there could be no doubt that when the whole of the lines in London were electrified, what had been promised in days gone by the Highways Committee would be fully realised. The present proposals would lead to a uniform system north and south of the Thames, would satisfy the legitimate needs of the Northern public. When the two systems were linked up, and the trams were able to go across the bridges, the profit earning capacity would be still further increased. He contended that the provisions of the lease were such that electrification could not proceed under it, and that it must be got out of the way. From the reports of the officers the Council practically had no alternative, and the terms given to the company were fair and reasonable, and favourable also to the Council. Incidentally he pointed out that of the 57 members who voted in 1896 for the lease, only 7 were now left, and some 34 or 35 members who then voted against the lease were still members of the Council. He estimated that if the tramways had been electrified at that date no less than a million sterling would have been gained by the Council in the ten years, especially considering the price at which capital could then have been raised.

Mr. H. P. Harris contended that North London had not been fairly treated by the Council. All the blessings of electric tramways had been given to the South, and while he was anxious for the Council to do everything in its power to improve locomotion in the North he wanted it to be sure that it was proceeding on the best methods and with due regard to approved finance. The Highways Committee had pursued a dilatory policy for some years and had suddenly become precipitate. The Progressive party had refused to take advantage of the electric traction clauses in the lease, and in support of this view he quoted from the proceedings of the Council and the Committee. As far back as February, 1901, a motion had been carried instructing the Committee to proceed under those clauses, but the Committee had never reported upon the instruction. He claimed also the support of the Finance Committee which said that it would be difficult to put those clauses in operation without the co-operation of the Company, but that only meant that co-operation of the Company could not be forthcoming owing to the delay in putting the clauses in force. It seemed, therefore, that while the Council had not been lacking in the power to electrify the North all these years, they had been lacking the will, the result being that all the advantages to have been gained from earlier electrification had been lost to the Council. The question for them that day was: is it desirable that the Council should commit itself to all that was involved in the proposals of the Committee? If that proposal was only to buy the lease, the matter might not be so important, but the proposal involved much more than that. The Finance Committee had pointed that out. Lord Welby's Committee said that the Council would be committed to Northern electrification for the most part on the conduit system, and urged that in entering upon a scheme of that magnitude it was most important that the financial considerations should be most carefully weighed. The Committee added that there were various factors in the solution of the traffic problem of London, the operation of which it was impossible to foresee, but which must have a bearing upon the financial results of the Council's tramways, viz., tube railways, electrification of suburban railways, and motor 'buses. The Finance Committee also urged the necessity of the strictest economy in capital expenditure, and the exercise of caution in dealing with proposals to lower fares or increasing the working expenses. Now he would not express any opinion as to the place to be taken in London locomotion by tubes, or tramways, or motor 'buses, or even steamboats, but there seemed to be a tendency just now to run one form of locomotion against another. He thought, however, it was unwise to back any winner at the moment, and in embarking on this large expenditure they must remember they were committing themselves entirely to one of the several competing methods. The adoption of this report practically meant pledging themselves to the most expensive method of conduit, and they must remember that after reconstruction, when electrification was completed, the margin of profit admitted by the report was almost nominal. Under all these circumstances he thought the Council would at any rate be acting prudently to wait for the report of the Royal Commission on London Locomotion, which would shortly be issued. Nothing would be lost by a slight delay, and to adopt the report that day would certainly be condemned as unbusiness-like. He therefore moved as an amendment, "That it is inexpedient for the Council to commit itself to the immediate purchase of the North Metropolitan lease, and the electrification of the lines on the conduit system, involving the possible outlay of six millions, until the shortly expected report of the Royal Commission on London Locomotion has beeen presented, when the needs of London and the precise means by which they may be most conveniently and economically met are likely to be more clearly ascertained."

Sir R. M. Beachcroft formally seconded, reserving his remarks.

Mr. J. W. Benn, M.P., said that he spoke with trepidation, being conscious that Sir Melville Beachcroft was lying in wait for him. He did not think Mr. Harris's speech hung together very well. He could not see why they should hold their hands, because whether they proceeded under the lease or outside the lease the magnitude of the proposals would be the same. Hurry in one case could not be justified unless it were justified in the other. The policy of the Moderate party in the past had been that in passing the resolution to purchase there was no intention on the part of the Council to work the tramways. That policy seemed to be still at the back of Mr. Harris's mind. Referring to the electric clauses in the lease, Mr. Benn said the first thing they discovered when they tried to put those clauses in force there was another clause which provided that those clauses should not apply to London. The Moderates were significantly silent on that point. Then the Company were entitled to quiet enjoyment under the lease, and if the Council had proceeded to electrify there would have been a heavy claim for compensation. But something else happened, and that was the creation by Mr. Harris's party of the Borough Councils, who told the Council they would not consent to the conduit system. The Borough Councils were given the control of the roads. Then, when the Council formulated a scheme for electrifying the North, the Company told the Council they would not assist unless the

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trolley system were adopted. In face of these difficulties, reconstruction was impossible. They might as well talk about electrifying the Moderate party. They had obtained a legal opinion that it was not possible to give effect to those clauses. The lease would stand in history as the greatest municipal blunder, and it had proved the Nemesis of the Moderate party. By the action of the Progressives in getting the percentage on gross receipts raised from 5 to 12½, the sum of £67,000 had been gained to London. There was another defect in the lease, which, while it provided for £12,500 being set aside for renewals of the lines, contained no power to compel the Company to spend that money, so there was an item of £30,000 which the Council could not touch. They were quite familiar with the plea of waiting for the report of the Royal Commission, and without venturing to be a prophet, he would say that one item of that report would be a recommendation for the rapid extension of the Council's tramways which had been such a benefit to South London. He had ventured to hope that the Moderates would have joined hands with them in this matter, and have shared the credit as was done in such Conservative centres as Liverpool or Manchester.

Sir R. M. Beachcroft, as one of the old reprobates who walked out of the Council in 1896, contended that in regard to the lease the Progressives had entirely misconceived the situation. When the lease was granted the Council had no alternative, because only part of the lines were then purchasable under the 1870 Act, other portions periodically falling in up to 1901. The Council could not then have electrified the system even had they wanted to, and nothing short of an agreement with the Company enabled the Council to deal with the Northern lines as a whole. He was proud of the lease, because out of the £293,000 carried to relief of rates from the tramways, no less than £200,000 had come from the lease, and only £78,000 from the South; that was up to 1902, since when the Northern system had produced £87,700 and the South a deficit of £26,000. He bitterly complained of a suggestion made by Mr. Benn that he and his friends had carried the lease for the benefit of the Company.

Mr. Benn emphatically disclaimed any intention of suggesting that Sir Melville Beachcroft or his party had been actuated by any personal motives, and said that what he had meant to convey, that being pledged to the idea that the Company system was the best, had in that way befriended the Company.

Sir R. M. Beachcroft willingly accepted the disclaimer, and said that he quite believed that Mr. Benn had not desired to cast any imputation upon the Moderate members. Proceeding, he reminded the Council that a legal opinion had also been obtained that the Council were entitled to electrify under the lease without incurring claims for compensation for disturbance

Mr. Benn, intervening, said that the same counsel had pointed out that the difficulty of compelling the Company to take power from the Greenwich generating station was insuperable.

Sir R. M. Beachcroft rejoined that while that was so, the Company could have got ample power from other sources. He pointed out that even now the Council were not ready to electrify the North, and yet were prepared to throw away £58,000 a year. Only half the lines had been dealt with on the South, and 25 miles still remained. At that rate how long did they think the work would take on the North? They were told when finished there would only be a profit on the whole transaction of £60,000, and, when the cost of widening was deducted, that would only leave £30,000 a year against the £58,000 they were now receiving. This was without reckoning the loss during reconstruction, and also it presumed the work would be a success. What if it failed? Personally, he believed that the conduit system for the whole of London would prove a failure, and contrasted Continental and American methods of providing for electric locomotion with the expensive system adopted by the Council. If, as a result of the Royal Commission's enquiry, they had to revise their decision that day, the Council would look extremely foolish.

Mr. J. Burns, M.P., urged that in order to secure a uniform system of tramway locomotion for London they must buy the company out. The terms were too generous by about £40,000, but he was prepared to vote for that sacrifice in order to expedite matters. He knew what the suggestion to wait for the report of the Commission meant. It meant that they were to wait for the creation of a nice little transit board, composed of ex-colonels, ex-generals, and ex-lawyers, to supercede the Highways Committee. A Government which reported in favour of such a step would not last long enough to carry out such a scheme. As to American methods, he could quote a better place than New York. Chicago had decreed in favour of municipalisation, and had sent to Glasgow for help to get free from the corruption obtaining under company rule in American cities. He denied that electrification would obstruct trade, and quoted South London circumstances as proving the commercial benefits of electric traction. He referred to the growing success of the Council's trams, and said that they had been conspicuously free from labour troubles and breakdowns. One man told him that for nine months his car had not been seriously interfered with by any breakdown. The men were getting more skilful and ready to take those necessary risks inseparable from work on an electric car. He expressed the belief that but for the blunder in regard to the lease nine years ago the Moderate party would have been as supreme at Spring Gardens as they were in Parliament.

Sir H. Bliss said that he could not understand why the Council wanted to throw away four and a half times £58,000, which meant £246,000, and another £100,000 on top of that. Why did they want to take over tramways which were returning a profit, when admittedly after the transaction there would be no profit. He also urged that experiments should be made with motor tram-cars before the Council finally committed itself to this huge expenditure for electric traction.

Mr. Allen Baker, in replying, said that the suggestion that in 1896 the Council had no alternative was inaccurate, as the lines which fell in then amounted to 19 miles of main routes, and the company could not have worked the remainder.

On a division the amendment was rejected by 74 votes to 21, and on a further division the recommendation of the committee to purchase the lease was carried by 68 votes to 20. The consequent recommendations were then agreed to *nem. con.*

Lord Welby, chairman of the Finance Committee, in submitting the annual estimates, referred at some length to tramway matters. He said that the Council would note with satisfaction the improvement in the financial results of the working of the Southern tramways for the past year. It appeared from the latest figures that the profit on working would be larger than originally estimated by a sum of £35,000, the greater part of which the Highways Committee proposed to employ—(1) in paying off the debt incurred on the temporary generating stations; and (2) in increasing the renewals reserve fund, thus increasing the financial stability of the undertaking. The estimates for the new year showed that the Southern system account just about balanced, but this was after providing only £15,000 for renewals reserve. They were promised better results when the first portion of the new generating station at Greenwich was opened in the spring of next year, as the Council would then be supplying electric current from Greenwich at a much cheaper price than that at which it was now being supplied as a temporary measure by certain companies. This led him to refer to the proposed purchase as on March 31, 1906, of the remainder of the lease granted by the Council to the North Metropolitan Tramways Company, which was now before the Council. This purchase was intended to be followed by the immediate electrification of the whole of the Northern system, at a cost, including all expenses incidental thereto, of from £4,000,000 to £5,000,000. The total outlay of the Council upon the purchase and reconstruction of existing tramways and the construction of new tramways would in a few years' time have reached a total of £11,000,000 or £12,000,000. The ratepayers would have lent their credit for the raising of this large sum of money, although the tramways undertaking had not, up to the present, cost the ratepayers a sixpence: on the contrary, they had directly benefited to the extent of nearly £300,000. The large additional burden which the service of education threatened to place upon the ratepayers made it imperative that the Council should make every effort to relieve the ratepayers in other directions, and he thought, therefore, that the ratepayers should when the undertaking had emerged from the period of reconstruction receive consideration, and that it ought to be consistent with the financial stability of the undertaking to contribute a certain sum annually in relief of the rates.

Tramway and Steamboat Services.

At a meeting of the Council on May 23, the Highways Committee presented a report on the subject of circular journey tickets available by the Council's tramways and river steamboats. They pointed out that on March 7 last, the Council had decided that the fares to be charged on the steamboats between Westminster and Greenwich should be 3d. single, and 5d. return. A special provision was included in the Thames River Steamboat Service Act, authorising the Council to make arrangements for the issue of circular journey tickets on the tramways and steamboats, and the Rivers Committee had been in communication with the Highways Committee on the subject. The present single fare by tramcar between Greenwich and the London termini was 3d., while it was proposed that the fare of 5d. charged on the steamboats should be equally divided between the revenue of the tramways and steamboats. This meant that 2½d. would be charged for each journey on the tramways if the passenger travelled the whole or only part of the journey by car. The committee concurred in the adoption of such an arrangement, but were of opinion that it should, in the first instance, be for a year only. They did not suggest that circular tickets should be issued for the outward journey in either direction of the tramways, as the shortness of the ordinary fare stages and the method of collecting fares generally would make that course difficult. They recommended that steamboat circular tickets at 5d. each in either direction between Westminster and Greenwich be available for the return journey on any of the Council's tramcars between Greenwich and the London termini.

Stoneware Ducts.

The Committee had considered tenders for the supply of 750,000 stoneware ducts required for the electric cables in connection with the

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reconstruction of portions of the existing tramways, and for the construction of various authorised tramways. The following were the tenders:

	Rate per 1,000 Ducts.	Amount of Tender (for 750,000 Ducts, including full Contingencies Provision).	Delivery per Week.
	£ s. d.	£ s. d.	
G. Skey & Co., Ltd., London	11 19 6	9,481 5 0	5,000
Stanley Bros., Ltd., Nuneaton	13 0 0	10,250 0 0	10,000
The Stourbridge Glazed Brick and Fireclay Co., Ltd., Dudley.	14 10 0	3,791 13 4 (for 250,000 ducts only)	4,000
John Knowles & Co., London	14 11 8	11,437 10 0	5,000
H. R. Mansfield, Burton-on-Trent	14 11 8	11,437 10 0	5,000
Hosea Tugby & Co., Ltd., Ashby-de-la-Zouch	14 11 8	11,437 10 0	5,000
Thos. Wragge & Son, Ltd., Swadlincote ...	14 11 8	11,437 10 0	50,000
Sutton & Co., Ashby-de-la-Zouch	16 10 0	12,875 0 0	5,000
Ingham's Firebrick Co., Dewsbury... ...	16 13 0	12,987 10 0	10,000
Jas. F. Cummings & Co., London	16 18 6	13,103 15 0	75,000
Naylor Bros., Huddersfield	21 0 0	16,250 0 0	7,500
J. J. Lee, Crumpsall, Manchester	24 0 0	18,500 0 0	10,000

The committee thought that the lowest tender, viz., that of Messrs. Skey and Company, should be accepted for the supply of 500,000 of the ducts. Having regard, however, to the more prompt delivery provided for in the second tender, they suggested that the remainder, 250,000 in number, should be obtained from Stanley Brothers, Limited. This would considerably expedite delivery and laying. The sum for the 500,000 would be £6,287 10s., and for the 250,000 ducts £3,450. The committee recommended accordingly.

Accumulators.

The committee had also considered the following eight tenders for the supply, delivery, erection, and maintenance of accumulators required at the Greenwich generating station.

	Amount of Tender. Supply, Delivery, and Erection.	Maintenance.
	£ s. d.	£ s. d.
The Tudor Accumulator Co., Ltd., London	1,875 12 0	1,120 0 0
The British Accumulator Co., Ltd., London	1,947 10 0	1,200 0 0
The Electrical Power Storage Co. Ltd., London ...	2,105 18 0	900 0 0
The D. P. Battery Co., Ltd., London	2,173 0 8	1,300 0 0
The Chloride Electrical Storage Co., Ltd., Manchester...	2,177 0 0	1,170 0 0
Accumulator Industries, Ltd., Woking	2,371 2 4	1,045 0 0
The A. B. P. Accumulator Co., Ltd., Stockton-on-Tees...	2,755 11 0	2,000 0 0
Hart Accumulator Co., Ltd., London	3,447 6 0	2,858 10 0

They recommended that the lowest tender, that of the Tudor Accumulator Company, should be accepted.

Overhead Travelling Cranes.

The committee had considered the following 26 tenders for the supply, delivery and erection of three 10-ton overhead travelling hand cranes required for the Streatham, Battersea, and Wandsworth sub-stations:

	£
Herbert, Morris, and Bastert, Ltd., Loughborough (not to specification)	477
Jessop and Appleby Bros. (Leicester and London), Ltd., Leicester (not to specification)...	620
James Gibb and Co., Ltd., London...	664
Carrick and Ritchie, Edinburgh	678
James Carrick and Sons, Ltd., Edinburgh	680
,, ,, ,, ,, alternative...	761
J. Smith (Keighley), Ltd., Keighley	699
Holt and Willett, Cradley Heath	735
Rogers and Kaye, Bradford	740
John Hitchen and Son, Ltd., Halifax	760
,, ,, ,, ,, alternative	725
C. and A. Musker (1901), Ltd., Liverpool	810
Tangyes, Ltd., Birmingham	871
Ransomes and Rapier, Ltd., London	909
James Spencer and Co., Hollinwood, Lancashire	915
Pickerings, Ltd., Sockton-on-Tees	927
John M. Henderson and Co., Aberdeen	980
Joseph Booth and Bros., Ltd., Leeds	990
Thomas Larmuth and Co., Salford	1,025
Leeds Engineering and Hydraulic Co., Ltd., Leeds	1,085
Thomas Smith and Sons, Leeds	1,128
Flavell and Churchill, London	1,150
Steel Rope Pulley Block Co., Ltd., Sheffield	1,192
Rawlinsons, Ltd., Leeds	1,225
Parsons (Brierly Hill), Ltd., Brierly Hill, Staffs.	1,275
Cowans, Sheldon, and Co., Ltd., Carlisle...	1,290
Dougill's Engineering, Ltd., Leeds...	1,770
Butters Bros., and Co., Glasgow	2,385

The two lowest tenders did not comply with the specification and could not be considered. Certain drawings and detailed information did not accompany the third tender, and it appeared that the cranes provided for by it would not be so satisfactory for the Council's purpose as those specified in the fourth tender. The committee recommended that this fourth tender, sent in by Messrs. Carrick and Ritchie, should be accepted.

Pimlico Generating Station Site.

The Committee reported on negotiations for the settlement of a claim in respect to the acquisition by the Council of the interest in premises forming part of the site of the suggested Pimlico generating station. They recommended that the claim of the Cubitt estate trustees be settled for £7,500.

The Tramway Committee's recommendations were adopted, with the exception of the report on circular steamboat and tramway tickets, which was opposed and stood over until the next meeting.

Considerable discussion took place upon the tramway estimates, postponed from a previous meeting.

On a vote of £57,475 for electric traction repairs,

Sir R. M. Beachcroft said this was the actual expenditure last year, and therefore the £15,000 estimated for renewals was quite inadequate.

Mr. Baker explained that the cars were kept up out of revenue, and the £15,000 was an additional reserve altogether. The penny per car-mile, which would bring in about £48,000, was sufficient to provide for new cars three or four times over if they wore out. The estimate was approved.

On estimates for general expenses, horse £11,875, and electric traction, £27,485.

Mr. T. P. Gaskell said these items were principally for local rates and appeared quite inadequate. The demands of the local rates would increase. The provision for rates amounted to 3s. in the £, whereas the average local rate was about 8s. in the £.

Mr. Baker replied that the estimates had been carefully got out and economies which would be effected would bring the expenditure rather under than over the estimates. Local rates were fully provided for, being about £130 per mile on horse and £500 per mile on electric lines. The estimate was approved.

On the vote of £3,595 for income tax.

Sir R. M. Beachcroft said as the balance shown was only £143, it was difficult to understand on what this large amount was paid for income tax.

Mr. Baker said the undertaking was bearing reserves and so on which were reckoned as a profit on which they had to pay.

Lord Welby said the ways of the Inland Revenue were marvellous, and considered there were profits on which the Council had to pay the tax. There was no appeal. The estimate was approved.

Proposed South London Extensions.

At a meeting of the Council on May 30, the Highways Committee submitted a special report on the proposed construction of new tramways and the reconstruction of existing lines in South London. They stated that certain tramways had been authorised from time to time, the construction of which might be undertaken with advantage at the present time. The street widenings required had been nearly completed. The tramways referred to were: (1) from Camberwell Green to the junction of Lordship Lane and Crystal Palace Road: (2) from the terminus of the authorised tramways in Lordship Lane to Dartmouth Road, Forest Hill; (3) from Grove Vale to Stuart Road, Peckham; (4) from the existing tramways in New Cross Road to Rushey Green; and (5) from the existing terminus in Trafalgar Road, Greenwich, to a point near Blackwall Tunnel. The total length of these lines was about 17 miles, measured as single track, and if construction was immediately commenced it would be possible for it to be completed soon after the opening of the first portion of the Greenwich generating station. The accompanying table shows the details of expenditure and the estimated results of working during the year:

Description of Tramway.	Cost of Construction & Equipment. Construction of Tramway, including Cables and Ducts.	Cars.	Car Sheds.	Sub-stations.	Estimated Rec'ipts	Estimated Expenses of Working.	Interest and Sinking Fund Charges on Cost of Construction.	Estimated Surplus of Receipts over Working Expenses.
	£	£	£	£	£	£	£	£
1.	80,500 (a)	9,100	6,500	5,200	20,805	12,136	7,226	8,669
2.	42,800	3,500	2,500	1,500	6,023	3,832	3,498	2,091
3.	39,100	2,800	2,000	1,600	4,927	2,874	3,348	2,053
4.	105,400	8,000	5,500	4,400	16,425	9,581	9,070	6,844
5.	35,150	2,800	2,000	1,600	4,927	2,874	3,051	2,053
Total...	302,950	26,200	18,500	14,300	53,107	31,297	26,193	21,810

(a) Including £7,000 for bridge work.

(1) New line from Camberwell Green, *via* Denmark Hill, Champion Park, Grove Lane, Dog Kennel Hill, Grove Vale, and Lordship Lane, to junction of Lordship Lane with Crystal Palace Road.

(2) From the terminus of the authorised tramways in Lordship Lane, *via* Lordship Lane and London Road, to Dartmouth Road, Forest Hill.

(3) From Grove Vale, *via* Goose Green, East Dulwich Road, and Peckham Rye, to Stuart Road, Peckham.

(4) New line from the existing tramways in New Cross Road, *via* Lewisham High Road, Loampit Hill and Vale, to High Street, Lewisham, and reconstruction and doubling of the existing tramways, thence *via* High Street, Lewisham, to the terminus at Rushey Green.

(5) New line from the existing terminus in Trafalgar Road, Greenwich, *via* Blackwall Lane, to Blackwall Tunnel.

The estimated cost of construction provided for the use of the conduit system, as the Committee were of opinion that in order that the tramways might be satisfactorily worked, so as to permit of easy interchange

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of traffic, the increased cost of track construction was fully justified. In addition, the committee pointed out that tramways Nos. 3, 4, and 5 would be situated within a radius of three miles from Greenwich Observatory, so that only the conduit system would be permitted. The whole of the lines would be worked in connection with the car-sheds now under construction at New Cross and Camberwell, and from the sub-stations already working at those two points. The estimated surplus of £21,810 a year would, if 1d. per car mile were set aside for renewals, be reduced by £4,473, leaving £17,337 available for interest and sinking fund. These charges would in the first year amount to £26,193, together with £2,000 in respect of the debt on the existing Catford lines. The figures excluded the question of street widenings, the total estimated cost of which was £120,250. The interest and sinking fund on one-third of that cost would amount to £2,177 a year. The committee were in communication with the Improvements Committee with regard to the incidence of the cost of these widenings. The figures given included £7,000, for certain bridge reconstruction works. It was estimated that about 13,750,000 passengers would travel on the lines during the first year, irrespective of the traffic that would result from the connection of the lines with the existing system and from the increase of population of the districts concerned. The committee advanced a number of arguments in favour of the immediate construction of the tramways, and they recommended approval of estimates of £322,150, less £35,000 for rails and fastenings already provided for, and that steps be taken to obtain tenders for carrying out the works.

The Finance Committee, reporting on the subject, stated that the total estimated capital cost, including a proportion for car-sheds, sub-stations, etc., was £403,876. This included also £48,926 charged to the tramways account for street widenings. On the assumption that the receipts would be 1s. per mile (except in the case of the line from Lordship Lane to Forest Hill, where the estimate was only 11d. per mile), and that the working expenses were 7d. per mile, and allowing 1d. per car mile for renewals, there was on all the schemes taken together an estimated annual deficiency, after providing for interest and sinking fund, of about £13,000, which would decrease by about £550 per year as the debt was paid off. These figures included 1d. per car mile for renewals, and the debt charges included £2,541 in respect of the proportion of the cost of street widenings. The committee added that when the Council decided to undertake these schemes, it was estimated that they would be self-supporting, but in the light of experience it had been necessary to revise the estimates. It was, however, anticipated that there would be a considerable increase of traffic over that estimated for. The committee also pointed out liabilities which the Council had recently undertaken in respect to the northern system, and stated that it was necessary that the Council's borrowings during the next few years should be prevented from becoming unduly large. They were of opinion that the Council should postpone any further new large tramway schemes until the works to which the Council were committed were completed, and had become revenue producing. The Bridges Committee presented a report in connection with this tramway scheme, in which they pointed out that the work would involve the reconstruction of the bridge carrying Denmark Hill over the London, Brighton and South Coast Railway and the South Eastern and Chatham Railway. The Companies were prepared to make certain arrangements, and the committee recommended that the estimate of £7,000 be approved for carrying out the work.

Temporary Tramway Track.

The Highways Committee in their ordinary report recommended that express authority be sought in the Parliamentary Session of next year to enable the Council in connection with the reconstruction of its tramways to lay down raised temporary tramway tracks and to maintain car service thereon during reconstruction. This course was necessitated by the similar proposal having failed to find a place in the Council's bill of the present year.

Greenwich Generating Station.

The committee proposed that an expenditure on capital account not exceeding £3,500 be sanctioned for the execution of paving works and railway track in connection with the first portion of Greenwich generating station, and that the construction of foundations for a road between the river wharf and the engine-house and the foundation of any other paving works necessary in connection with the power-station be done by H. Lovatt, Limited, at the same schedule rates as those provided for in their present contract.

Streatham Sub-Station.

The committed stated that in June last year the Council approved an estimate of £7,500 for the erection of Streatham sub-station. Specifications and drawings had now been prepared and an estimate submitted amounting to £6,750. The Works Committee would be prepared to erect the buildings for £6,220. The total cost involved, including miscellaneous items, would be £7,150. The Committee recommended that expenditure to that amount be sanctioned, and that the erection of the buildings be executed by the Works Committee, the paving works to be carried out by the Council's permanent way staff.

The Council adopted the other recommendations, but under the standing orders, the large scheme stood over for a week.

THE COST OF LEICESTER ELECTRIC TRAMWAYS.

The electric tramway system of Leicester is generally and rightly regarded as one of the best and most modern systems in the country, and that being so, it is of special interest to learn exactly what the capital expenditure upon it has been. This is now available in the shape of an explicit and valuable report prepared by Mr. E. George Mawbey, borough and tramways engineer, which has been presented to the Tramways Committee of Leicester Corporation. The report says:

I beg to report fully upon the cost of the tramways scheme as carried out up to the present date, compared with the Parliamentary estimate. The scheme to the extent which the Council originally decided that it should be carried out having now been completed with the exception of a short length in Melton Road, it is possible to arrive at a fairly accurate conclusion as to the cost.

The accompanying table shows under the different headings the original Parliamentary estimate for all the work, etc., included therein; the portion of the Parliamentary estimate for the work carried out or in hand (exclusive of extensions); the actual cost of the same compared with the estimate; the savings and excess on the various items; and the net total saving on the whole scheme. I have also included a column shewing the amount allowed in the Parliamentary estimate for the portions of the scheme not yet carried out or in hand, and two columns shewing the surplus or deficiency on the whole Parliamentary estimate on the completion of the work in hand, exclusive of extensions.

It may be said at once that in these amounts I have included under the various headings all the street improvements chargeable to the tramways scheme; the whole of the salaries of that portion of my staff which has been engaged on the work; the consulting engineer's fees, the purchase of land for tramway purposes; the narrowing of footways; a liberal payment to the Highway and Sewerage Committee for altering the levels and re-coating the sides of macadamised roads; the lowering of roadways under bridges; compensations; and every other expenditure incurred in carrying out the scheme.

It will be seen from the table that the cost of the scheme as far as already carried out, and providing for the Melton Road length, is £469,746: that the Parliamentary estimate for that portion of the work was £475,021; and that, therefore, a net saving on the original scheme, after meeting all contingencies and extras on the above, of £5,275 has been affected. This saving is quite apart from the unexpended balance of £105,726 on the original scheme, as shown in the annexed table, money columns Nos. 1 and 2, by the difference between £580,747, the Parliamentary estimate for tramway works, and £475,021, the portion of the Parliamentary estimate for the work actually carried out.

36½ miles of single track are included in the above expenditure, which works out at £12,869·7 per mile of track for the original scheme as carried out, comprising permanent way, overhead work and bonding, power-station buildings and machinery, car depôts, and all equipments, 100 cars (instead of the 90 included in the estimate), and everything, as before-mentioned, appertaining to the scheme as embodied in the above table. The Parliamentary estimate for the whole scheme, as detailed in the previous paragraph, works out to £13,014·2 per mile of track, showing a saving of £144·5 per mile, or a total of £5,275, as before mentioned.

Not only has this saving been effected, but a good deal of work has been done and expenses met which were not provided for in the original estimate, notably the number of extra feeder conduits which, fortunately, were put in to provide for possible future extensions and requirements; additional earthing of telegraph wires; the providing of long lengths of temporary track for maintaining the horse traffic during alterations, and other expenses under the head of miscellaneous, given in the accompanying table. Were it not for the above, the saving on the estimate for the scheme would obviously have been much greater.

The largest of these savings is that on the construction of the permanent way, which was done by our own municipal staff without the intervention of a contractor, the cost of the construction of which has been £5,865·5 per mile of single track, against the Parliamentary estimate of £6,343·4 per mile, showing a saving of £477·9 per mile, or a total saving of £17,443, and this includes all the office and outdoor staff expenses incurred in preparing the Parliamentary plans, estimates, and working drawings, and in the superintendence of the works.

It might also be mentioned that adverse contingencies have had to be contended with; for instance, the weather was unsettled and unfavourable for tramway work during a large portion of the period of construction, and this seriously interfered with the progress and added to the cost. The gangs were kept working at full strength during the winter, a practice not usually adopted where it can be avoided. This was done to expedite the progress, to minimise the inconvenience to the public, and to avoid throwing large numbers of men out of work during the winter, when they most needed employment. The maintenance of

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the horse car service by means of temporary track throughout the construction also increased the cost of the works.

This cost was further increased by the necessity for putting in an additional thickness of concrete under the track in many places where the ground was almost honeycombed by conduit trenches, sewers, gas and water pipes, which had been laid just previous to the construction of the permanent way.

The cost of £5,865·5 per mile of single track for permanent way compares very favourably with the cost of permanent way in other towns, especially when taking into consideration not only the foregoing adverse conditions, but also having regard to the following facts, viz.: that good wages were paid; that the best English rails were purchased instead of paying low prices for foreign rails; that the most durable and expensive special track work available has been provided; that all the rail joints have been secured by anchors and extra concrete; and that a rather large proportion of Australian hardwood paving has been provided; whilst in the carrying out of schemes in other towns, at least some of these conditions do not obtain. In Leicester entirely new concrete has been provided for the track throughout, whilst in some of the large cities there has already existed to a large extent a good foundation, effecting a big saving in excavation and concrete. Neither should it be lost sight of that the quality of the track work in Leicester compares favourably with that of any other town, nothing having been spared to ensure the soundest and best running track possible.

The question may arise as to the disposal of the before-mentioned £105,726, the unexpended portion of the Parliamentary estimate for the work not yet carried out or in hand, together with the £5,275, the saving on work already carried out. About £30,000 of this, which was provided for the widening of Bedford Street, and over £6,000 of the amount provided for the parchase of land for car depôts, will not be required. The interlacing track and the narrowing of the footways in Belgrave Gate have made the Bedford Street route unnecessary. £19,000 of this balance will be required, as suggested by the Board of Trade, for the three additional car-shed bays for the extra cars required by the increased service.

The sum of £3,000, the value of old rails, etc., which was given credit for in the Parliamentary estimate, has now been credited to the old undertaking. Consequently the surplus on the estimate is reduced by that amount. The amounts provided for the coal-conveying plant for the power-station, and for the utilisation of the steam at the refuse destructor, have not yet been expended. Most of the remainder is represented by permanent way and overhead work not yet constructed.

Having now cleared up the scheme to the extent that it has already been carried out, it remains to deal with the additional plant rendered necessary for the extraordinary growth of the traffic

It will be remembered that the Board of Trade sanctioned the expenditure of £60,000 for additional power-station plant, feeders, cars, etc. If the whole of this £60,000, and also the £19,000 for the additional car-sheds to house the extra cars which we have now the power to purchase, were charged on to the 36½ miles of track, instead of upon the greater length of lines which it would serve, it would bring the cost per mile up to about £15,034, against the before-mentioned actual cost of £12,869 per mile of track for the Parliamentary scheme.

Even this greater cost per mile, however, including everything in connection with the scheme, is low, compared with the cost in some of the other large towns; but seeing that the Parliamentary scheme embraces 42½ miles of track, instead of 36½ as completed at present, and that the power-station plant now being laid down will be considerably more than sufficient for working 42½ miles of track, it is obviously unfair to charge this extra capital outlay upon the present 36½ miles, and, in fact, I find that in adding the cost of constructing additional lines up to 42½ miles, and charging the whole of the additional plant upon this length, the inclusive cost per mile of track would only then work out at £14,057 for the whole scheme.

These are certainly low figures, having regard to the character of the track work and the fact that in the engines, generators and equipments, the cables, overhead work, and cars, your Committee have taken care to secure plant, etc., of English make which, for efficiency and durability, can hardly be surpassed, thus ensuring the minimum of maintenance costs and working expenses, instead of doing cheap work or accepting the lowest tenders with the consequent risks and disadvantages; whilst the power-station and car depôt buildings are constructed and finished in the most substantial and durable manner.

STATEMENT OF CAPITAL EXPENDITURE COMPARED WITH PARLIAMENTARY ESTIMATE (EXCLUSIVE OF EXTENSIONS).

No. of Account.	Description of Work.	Total Parliamentary Estimate.	Portion of Parliamentary Estimate.	Cost.	Saving on Parliamentary Estimate.	Excess on Parliamentary Estimate.	Amount included in Parliamentary Estimate for work not carried out or in hand.	Surplus on whole Parliamentary Estimate.	Deficiency on whole Parliamentary Estimate.	Remarks.
			For work carried out or in hand (exclusive of extensions).					On completion of work in hand (exclusive of extens.)		
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	
1	Purchase of the old undertaking	...	...	...	...	...	...	...	...	Not included in Parliamentary estimate
2	Construction of tramways ...	275,960 11 9	231,534 0 0	214,091 2 1	17,442 17 11	...	14,426 11 9	61,869 9 8	...	
3 and 4	Feeder conduits and cables ...	27,500 0 0	22,850 0 0	29,187 18 3	...	6,337 18 3	4,650 0 0	...	1,687 18 3	
5	Earthing telegraph wires ...	2,000 0 0	2,000 0 0	3,347 0 0	...	1,347 0 0	...	...	1,347 0 0	
6	Overhead equip. and bonding...	45,239 8 3	38,212 0 0	36,014 3 8	2,197 16 4	..	7,027 8 3	9,225 4 7	...	
7	Power-station buildings and equipment	83,300 0 0	73,800 0 0	66,336 2 4	7,463 17 8	...	9,500 0 0	16,963 17 8	...	£5,000 included for coal conveying plant, and £4,500 for destructor boilers
8	Car depôts (Central and District) and alteration of offices	35,000 0 0	35,000 0 0	34,075 19 0	924 1 0	...	..	924 1 0	...	
9	Tram cars	54,000 0 0	54,000 0 0	52,713 12 3	1,286 7 9	...	...	1,286 7 9	...	
10	Purchase of lands for buildings	17,000 0 0	11,130 0 0	10,225 6 7	904 13 5	...	5,870 0 0	6,774 13 5	...	
11a	Purchase of land for street widenings	30,184 18 6	183 0 0	752 13 9	...	569 13 9	30,001 18 6	29,432 4 9	...	The unexpended balance is chiefly for Bedford Street improvement
11b	Works for ditto and for Bridge alterations	3,563 1 0	1,920 19 6	2,480 14 8	...	559 15 2	1,642 1 6	1,082 6 4	...	The excess is due chiefly to the London Road widening and the extra lowering under bridges not included in the estimate.
11c & 11d	Narrowing footways ... Making good sides, etc....	7,000 0 0	4,391 4 0	7,410 11 1	...	3,019 7 1	2,608 16 0	..	410 11 1	
14	Miscellaneous	...	...	13,111 3 11	...	13,111 3 11	...	..	13,111 3 11	
		580,747 19 6	475,021 3 6	469,746 7 7	30,219 14 1	24,944 18 2	105,726 16 0	127,558 5 2	16,556 13 3	
				Net Saving...	5,274 15 11					

LIGHT RAILWAY COMMISSION.

On May 1 the Light Railway Commissioners made and submitted to the Board of Trade for confirmation the Tottenham and Walthamstow Light Railways Order, 1905, authorising the construction of Light Railways in the urban district of Tottenham in the county of Middlesex. The Board of Trade have confirmed the Welshpool and Llanfair Light Railway (Further Borrowing Powers) Order, 1905, amending the Welshpool and Llanfair Light Railway (Amendment) Order, 1901, and for other purposes.

On May 8 the Commissioners submitted to the Board of Trade for confirmation the Axholme Joint Railway (Hatfield Moor Extension Light Railway) Order authorising the construction of light railways in the County of Lincoln and in the West Riding of the county of York. On May 10 the Commissioners submitted to the Board of Trade for confirmation the Bath Electric Tramways (Light Railway Extensions) Order, 1905, authorising the construction of a light railway in the rural districts of Bath and of Keynsham in the county of Somerset (being an extension of the existing and authorised undertaking of Bath Electric Tramways, Limited).

On May 17 the Commissioners issued their draft Bideford, Clovelly, and Hartland Light Railway Order, authorising the construction of light railways in the county of Devon, from Bideford to Clovelly and Hartland.

The Board of Trade have confirmed the following Orders:

Guildford Light Railways Order, 1905, authorising the construction of light railways in the parish of Stoke-next-Guildford, in the rural district of Guildford, and in the borough of Guildford, in the county of Surrey; Campbeltown and Machrihanish Light Railway Order, 1905, authorising the construction of a light railway in the county of Argyll, from Campbeltown to Machrihanish. The Commissioners on May 19 issued their draft Tarporley Light Railway Order authorising the construction of a light railway in the county of Chester, from Tarporley to a junction with the railway of the Cheshire Lines Committee near Mouldsworth.

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TRAMWAY AND ELECTRIC RAILWAY LEGISLATION.

SECOND READINGS.—In the House of Lords, May 9: Accrington Corporation. May 11: Birmingham Corporation. May 18: Whitechapel and Bow Railway, Great Western Railway (New Railways), Halifax Corporation, Croydon Corporation, Swansea Corporation. May 22: Baker Street and Waterloo Railway, Edgware and Hampstead Railway, Charing Cross, Euston, and Hampstead Railway. May 25: London United Tramways (Extension of Time).

In the House of Commons, May 2: Southend and Colchester Light Railways. June 1: North East London Railway.

THIRD READINGS.—In the House of Lords, May 25: Nottingham Corporation. May 29: Metropolitan and Great Central Railway Companies, Gosport and Fareham Tramways, Hastings Tramways, South Lancashire Tramways. May 30: Croydon Corporation.*

In the House of Commons, May 4: Halifax Corporation. May 5: Croydon Corporation, Swansea Corporation. May 11: Baker Street and Waterloo Railway, Charing Cross, Euston and Hampstead Railway, Edgware and Hampstead Railway, West Cumberland Electric Tramways (Extension of Time). May 15: London United Tramways (Extension of Time). May 19: Metropolitan District Railway.* May 22: Tyneside Tramways and Tramroads.* May 24: Great Northern, Piccadilly, and Brompton Railway (No. 1). May 25: Mexborough and Swinton Tramways (Extension of Time)*, Rhondda Urban District Council.

ACCRINGTON CORPORATION.—Intimation was made to the House of Lords on May 12, that the opposition to this bill had been withdrawn.

BIRMINGHAM CORPORATION.—A Committee of the House of Lords on May 19 had this bill before them, but as it was intimated that the opposition had been withdrawn the measure was referred to the Committee on Unopposed Bills.

BLACKPOOL IMPROVEMENT.—Official intimation was made on May 13 that this bill was now unopposed.

DUBLIN UNITED TRAMWAYS.—This bill for the consolidation of the two Dublin tramway companies was passed by a Committee of the House of Commons on May 19. It was explained that all the shares in the Dublin Southern Company were already held by the Dublin United Company, and it was simply a case of getting Parliamentary confirmation of a purchase already carried out. It was also stated that a clause would be inserted in the bill protecting existing rights of the Corporation and other local authorities. The Committee on May 23 adjusted the necessary clauses.

GLASGOW CORPORATION (TRAMWAYS CONSOLIDATION.)—A Commission sitting in Glasgow, under the Scotch Private Legislation Procedure Act, began the consideration on May 8 of this Provisional Order application. Opposition by railway companies, neighbouring local authorities, frontagers, etc., was represented. Mr. Salvesen, K.C., Solicitor-General for Scotland, who appeared for the promoters, said that the object of the Order was to consolidate the Corporation's 16 Acts relating to tramways, and to authorise certain extensions. Some proposed lines were to be in Partick, but as an agreement could not be reached with the Council of that burgh these lines were withdrawn. The same statement applied in the case of a proposed line to Barrhead, as Renfrewshire County Council objected. A proposed tramway in the residential district of Kelvinside had been withdrawn as it was not desired by the inhabitants. Several of the remaining lines were opposed by the railway companies on the ground of competition and that certain streets were too narrow. The object of the promoters was to connect by these lines the diverging spokes of a wheel, that was the existing tramways radiating out from the centre of Glasgow, and also to make extensions further into the country. He detailed several of the proposals, and in regard to the consolidation part of the Order he said that the power to run omnibuses in prolongation of the tramways was limited to three miles, and the time to one year. This was a new power to some extent, but the running of omnibuses had been found the best way of ascertaining where there should be in any district an extension of the tramways. It was sought to carry parcels and goods up to 500 lb. weight, a power already existing in regard to Clydebank tramways, and to distribute parcels throughout the city. In the evidence, Mr. James Dalrymple, the general manager, said that the proposed lines would extend to 17 miles inside the city and 13 outside, measured as single track. He combated objections to various lines, and as to the carrying of parcels he cited other towns which had the power to carry these up to 500 lb. weight. As to the claim by some opponents for lower fares for workmen, he said that the present fares for everybody were less than those formerly charged to workmen, and if a still lower scale for artisans was instituted it would almost ruin the tramway department. In cross-examination he said that the Corporation of Glasgow, so far as tramways were concerned, knew no boundaries. They carried the population as far as they wished to go. Mr. Hugh Alexander, convener of the Tramways Committee, and Mr. C. A. King, C.E., also gave evidence for the scheme, and they were followed on the same side, at the sitting of the Commission on May 9, by residents in the districts concerned. Witnesses were then heard for the opposition, the first section to be taken being the Canniesburn line. Here it was stated that local feeling was against the tramway. The chairman (Mr. E. Wason, M.P.) intimated that the line would only be sanctioned as far as Garscube Bridge. After evidence had been heard for the railway companies against the Baillieston and Uddingston extensions, the Commission approved and sanctioned these lines. The railway companies also opposed the project for a tramway from Castle Street to Millburn Street, but on May 10 the Commissioners granted the line. On this, the final day of the hearing, power was granted to the promotors to lower the level of Dumbarton Road, in Partick, so as to allow top-covered cars to pass under bridges. After hearing objections to the proposed power to carry parcels on the tramways, the Commission sustained an objection by Renfrewshire County Council, and indicated that Clause 70 must be amended so as to provide that the carrying of parcels must not be exercised on the lines in Renfrewshire without the consent previously obtained of the County Council. Apart from this the clause was approved. In regard to Clause 45 (power to run omnibuses), the Commission granted the clause, subject to the proviso that in the case where the running of the tramway cars is interrupted, the omnibus running powers shall not be exercised beyond a radius of three miles from any point on the tramways, and shall not, without the consent of the Board of Trade, be exercised in the case of any one route for a longer period than one year. The other proposals of the Order were sanctioned.

GREAT WESTERN RAILWAY (NEW RAILWAYS).—This bill was before a Committee of the House of Lords for several days in the end of May. It, however, transpired that the proposed line, in which our readers may be interested—that from Ealing to Shepherd's Bush—was now unopposed.

HAMMERSMITH, CITY, AND NORTH EAST LONDON RAILWAY.—In the House of Commons, on May 11, Sir Edward Strachey moved that the report of the Select Committee on Standing Orders of March 7 last on this bill be referred back to the Committee to consider and report where the Standing Orders might now be dispensed with, and the parties permitted to proceed with their bill in respect of certain of the railways and works proposed to be authorised, subject to such conditions as to the Committee might seem meet. Having touched on the various failures in recent years to get this through-route sanctioned, he said that in view of the statement of the Board of Trade that bills of the sort would not be considered till after the Traffic Commission had reported, the promoters of this year's bill had not lodged the deposit money of £300,000 required, and on that technical ground the Standing Orders Committee had reported that the bill should not be proceeded with. The promoters now sought to proceed only with that part of the bill referring to the portion of the line from the City to North East London, as a competing measure, the North East London Railway Bill, was now awaiting second reading. If that scheme, which had been rejected in previous years, was to be considered this year, the competing part of the Hammersmith Bill should also be considered. The promoters were prepared to lodge the deposit money. If, however, the North East London Bill was not to be proceeded with this year, the promoters of the Hammersmith Bill would not press for the consideration this year of any part of their scheme. Mr. Jeffreys, Deputy-Chairman of Ways and Means, said he trusted that the House would not accede to the motion, because such a course should only be taken in very exceptional circumstances. No very exceptional circumstances had been shown in this case. The fact that there was a competing scheme was no reason for sending back the bill. Mr. Halsey, Chairman of the Standing Orders Committee, also opposed the motion, and said that a large number of the Standing Orders had not been complied with. After further discussion the motion was rejected by 133 votes against 71.

HASTINGS TRAMWAYS.—It was officially announced on May 12 that the opposition to this bill had been withdrawn.

LONDON COUNTY COUNCIL (TRAMWAYS).—The Standing Orders Committee of the House of Commons on May 16 considered a petition to dispense with the Standing Orders and allow an additional provision to be inserted in this bill. The additional clause was to give power to the promoters to lay down temporary rails for the purpose of maintaining the service of cars in any street in which a tramway belonging to the promoters was in course of reconstruction for electric traction. The Committee decided that the Standing Orders should not be dispensed with, and the clause accordingly will not be inserted in the bill. On May 18, a Committee of the House of Commons, presided over by Mr. Kearley, began consideration of the bill itself, the chief object of which is to authorise the construction of tramways on the electric conduit system from the present terminus at Westminster Bridge across that bridge, along the Victoria Embankment, and across Blackfriars Bridge to the existing terminus there. The bill also provides for a spur line into the tramway-subway at Waterloo

* These bills have completed all their stages.

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Bridge, so as to complete the connection with the North London tramways, and for a connecting link with the existing horse line on the Albert Embankment. The principal opponents represented before the Committee were the Corporation of the City of London, the Metropolitan District Railway Company, and frontagers on the Embankment. Most of the first day's sitting was taken up by the opening speech of counsel for the promoters, and by evidence on the same behalf by Mr. M. Fitzmaurice, engineer to the County Council. It appeared that the opposition by the City of London was based on the alleged unfitness of Blackfriars Bridge for a tramway, owing to the amount of traffic on it, and on interference with the City of London School at the east end of the Embankment. The District Railway opposed because the company feared injury to the roof of their tunnel under the Embankment from the construction of the tramway conduit. They also opposed on the ground of competition. A memorandum was submitted from the Home Office embodying the views of the Commissioner of Metropolitan Police in regard to the line across Westminster Bridge. He was afraid that the tramway would lead to congestion and interruption of traffic which might result in interference with access to the Houses of Parliament. For the promoters it was pointed out that the spot at which the cars would turn from the bridge on to the Embankment was several hundred feet from the entrance to the Houses of Parliament, that the width of the bridge and of the Embankment provided ample room for the carrying on of the service without any interference with traffic, and that the turning of a car into or from the Embankment would lead to no more interference with traffic than would be caused by a hansom cab in similar circumstances. The Committee announced that they would consult with the Home Office on the point. It was mentioned that the estimated cost of the entire scheme was £106,400.—On May 19 Mr. Fitzmaurice, resuming his evidence, said it was anticipated that there would be a one-minute service of cars over Westminster and Blackfriars Bridges. The cars would not stop on the bridges to pick up passengers, but he had no doubt there would be several stopping places along the Victoria Embankment. He had considered all the alternatives to carrying the tramways over the bridges, and none afforded anything like the same public and practical advantages as the present proposal. In cross-examination he declined to accept the suggestion that the running of tramways along the Embankment would greatly increase the cost of maintaining that thoroughfare. It was a fallacy to say that there was any sinking of the Embankment. Every precaution which could be suggested by the Board of Trade or the police for the safety of the public where cars came out of the subway on to the Embankment would be adopted by the Council. In re-examination, he said that there was ample room above the arch of the District Railway for the construction of the tramway conduits on the Embankment. Mr. J. Allen Baker, chairman of the Highways Committee of the County Council, testified to the benefits which would arise from the abolition of the present dead ends at Westminster and Blackfriars. In all probability cars would run alternately on the circular route and through the subway to Holborn. Single-deck cars would be used for the subway route. Mr. H. E. Haward, controller to the County Council, stated that the estimates showed that with receipts of 1s. per car-mile the revenue would be £46,000, and the working expenses at 7d. per car-mile would amount to £27,000. Interest and sinking fund would be £10,500, and renewals at 1½d. per car-mile, £5,700. Thus the surplus for the first year would be £2,800, and this would increase every year as the debt was paid off.—The Committee sat again on May 23, when miscellaneous evidence was heard in support of the bill.—On May 24 the case for the promotors was concluded, and witnesses were heard on behalf of frontagers who objected to the noise which would be caused by the cars. On behalf of the Metropolitan District Railway Company, Mr. G. Estall, engineer, said that for a distance of 740 yards along the Embankment the tramway would run above the tunnel of the railway. The roadway was supported on iron girders and the depth of the soil was in places not more than 18 inches. The girders were not constructed to stand the stress from heavy tramway cars. Reconstruction of the roof of the tunnel would involve heavy expenditure, and the cost should be borne by the County Council.—On May 25 Captain Bower, Commissioner of the City of London Police, said that the tramway across Blackfriars Bridge would cause further congestion of the traffic. Between 8 a.m. and 8 p.m. on a week-day 15,953 vehicles passed over the bridge, and 10,865 crossed the north end of it by way of the Embankment and Queen Victoria Street. The tramway would also change the four lines of traffic—two lines of fast and two of slow traffic—into two lines of traffic, as all vehicles would be driven to the sides of the roadway, and the streets would be blocked. The traffic would also have to be held up owing to the cars turning from the Embankment on to the bridge and *vice versa*. As regards the probable number of passengers that would use the cars going along the Embankment, he said that out of a total of about 32,000 people crossing Blackfriars Bridge northwards in a day, over 28,000 went north or east, and only about 3,000 went west along the Embankment. Mr. E. R. Henry, Chief Commissioner of the Metropolitan Police, was called by the Committee, and he objected to the tramway across Westminster Bridge on the ground of its blocking the traffic. Evidence was also given to show that the City Corporation did not contemplate widening Blackfriars Bridge. This concluded the evidence. On May 26 the Committee deliberated for an hour and a half in private, and subsequently intimated that they had passed the preamble of the Bill. The chairman, Mr. Kearley, in announcing the decision, said that the Committee had decided that the widening of Blackfriars Bridge was imperative, and they found the preamble proved, subject to a clause to give effect to that decision being inserted. The Committee also gave authority for the construction of the subway extension, but they omitted the connection with the tramway on the Embankment. Some question arose as to who was to widen the bridge, as the County Council had no power to do it, and it was doubtful whether the City Corporation would do it. The chairman said that the Committee had considered that matter, and it would come up again when they came to deal with the clauses of the Bill. The committee adjourned till May 31. When the Committee resumed on that day, the unopposed clauses of the bill were dealt with and passed. They included proposals to divert for a short distance the Lewisham line; to construct a length of one furlong continuing the Croydon system to the entrance of the Crystal Palace; to equip electrically the line over Vauxhall Bridge sanctioned in 1896; to extend the time for construction of tramways north of the Thames to 1908, and to repeal the section in the Act of last year enabling the police authorities to require cars to stop short of the present terminus in Westminster Bridge Road. The Blackfriars Bridge question was then again taken up. Mr. Erskine Pollock, for the promoters, submitted a clause providing: (1) The Council shall not commence to construct tramway No. 2 within six months from the passing of this Act. (2) If within that period the Corporation give to the Council notice stating their opinion that the width of the bridge is insufficient for the tramway, and stating the manner in which they consider the bridge should be widened and the proportions in which they consider the cost of widening (including costs incidental to obtaining necessary statutory powers) should be borne by Council and Corporation; and if within six months of receiving such notice the Council state objections to the conditions, a difference shall be deemed to have arisen to be determined by arbitration. In the absence of objection the Council shall be deemed to have assented to the terms and shall, before beginning construction wait until the widening work is completed. (3) An arbitrator shall be appointed by agreement or on application to the Institution of Civil Engineers. (4) Nothing shall prevent the Council from constructing the tramway without any widening of the bridge after the expiration of six months; (*a*) if the Corporation shall not within that period give notice, or (*b*) if the Corporation shall not have substantially commenced to widen the bridge in accordance with notice, and within two years from the date of such notice in the event of the Council not having made objection or within two years from the date of the determination of a difference by arbitration. Mr. Pollock said that a widening of 11 ft. would probably be sufficient, and it might be done without any work in the bed of the river. The proposal contemplated a bill for powers next year if that should be necessary It might be that the Corporation would determine to widen the bridge for all purposes. The Committee again deliberated in private, and subsequently the Chairman said that the Committee were unanimously agreed that without the widening of the bridge they would be unable to pass the bill or any part of it. The Committee were advised that by the clause proposed other parties, the Thames Conservancy, for instance, might be affected, and of necessity this would entail another bill next year. Therefore, unless some agreement could be arrived at with the Corporation, the Committee were agreed that it would be useless to proceed further. If there was any possibility that the Council and the Corporation would come to agreement, the Committee would be willing to adjourn for any reasonable time. The Committee had determined that, unless they could get the bridge widened, they could not grant the bill; in their view there should be the circular system. Mr. Erskine Pollock said he did not anticipate that any technical difficulties would arise with the Thames Conservancy. The Chairman said it appeared that in the clause submitted it was intended that the County Council should have power to go on making the tramway, if, at some period reasonably near, the Corporation did not come to some agreement. This the Committee had discussed very carefully, and they were not prepared to give the County Council that power. Mr. Erskine Pollock said he would be glad to have the opportunity for discussion and conference with the Corporation. The Chairman said he had no objection to express the view of the Committee that they agreed the scheme was a beneficial one. The only obstacle being the widening of the bridge, they hoped an agreement would be arrived at. They felt that the tramway was a needed improvement in traffic facilities. The Committee adjourned to June 26.

LONDON SOUTHERN TRAMWAYS.—This bill came before the Committee of the House of Commons on May 30, and it was opposed by the London County Council, Alleyn's College, and the South London Electric Supply Corporation. Mr. Balfour Browne, for the promoters, the South London Tramways Company, said that the tramways concerned covered a route of over five miles from Norwood Cemetery to Vauxhall Station and from Camberwell Green to

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Brixton. The lines were partly double and partly single track. The London County Council did not exercise their right of purchase in 1904 under the Tramways Act, and the Company were allowed to go on for seven years more. The undertaking was now a horse tramway, and the bill proposed to give the Company power to equip it electrically on the trolley system at a cost of £170,000. The Company could not in seven years recoup themselves for that expense, and therefore they asked Parliament to extend the time before the County Council could purchase to forty-two years. It was proposed to erect a generating station on the Dulwich College estate and to raise £105,000 of new capital. Mr. Wm M. Murphy and Mr. S. Hunt, Mayor of Lambeth, gave evidence in support of the bill. On May 31, Mr. Edwards, engineer of Lambeth Borough Council, stated that the promoters proposed to carry out the works with the consent and to the satisfaction of the municipal authority. In reply to Mr. Charteris, for the County Council, the witness said that in 1903 the County Council made it a condition of their purchase and electrification of these tramways that the Borough Council should contribute £40,000 towards street widenings. The borough Council refused, but in May of this year they agreed to contribute £25,165 if the present bill were rejected, and the County Council pledged themselves to complete the electrification of the lines in three years. After other evidence, the Chairman (Mr. Ashton) said that the promoters need not proceed any further, as the Committee were of opinion that the preamble was not proved. Mr. Vesey Knox, for the promoters, said that they still had a great deal of engineering and other evidence to call. It was contrary to the practice of Parliament for a decision to be given before the promoters' case was concluded, and he entered his protest. The Chairman said that the Committee were not bound to hear more evidence than would satisfy them that the preamble of the bill was not proved. Mr. Knox repeated that it was contrary to the practice of Parliament to decide against a bill before hearing the whole of the promoters' case. The Committee then rose.

METROPOLITAN AND GREAT CENTRAL RAILWAY COMPANIES. A Committee of the House of Lords on May 22 passed this Bill as unopposed. The London County Council sought to be heard against it, but were refused a *locus standi*. The Bill confirms an agreement for making the Metropolitan Company's line from Harrow to Verney Junction, Buckinghamshire, a joint undertaking of the two companies.

NORTH EASTERN RAILWAY.—This bill was before a Committee of the House of Commons on several days in the middle of May. Among the objects of the measure is one to empower the company to own and work omnibuses in any district or to or from any place served by the company's railway, and to carry passengers and goods, and this proposal was considered at length on May 17 and 18. Mr. Moon, K.C., for the promoters, said that the clause, as originally introduced, gave a wide power, which would enable the company to set up lines of 'buses from the railway system to places remote from the railway, and was not necessarily confined to traffic from the railway. This clause was not the invention of the promoters; it was copied from the Great Eastern Railway Act of last year. When the North Eastern Railway Bill came before the House this session an instruction to the Committee had been moved that they should limit the provision of clause 38 to omnibuses, coaches, and cars "conveying persons, passengers' luggage, parcels, and goods to and from the company's railway stations." In the course of the debate Sir Edward Grey explained that it was never intended in the interests of the company to run the omnibuses other than to and from their passenger stations, and he expressed his willingness, on behalf of the railway company, to consider some safeguards which might be afforded. On that understanding the instruction was withdrawn. The clause had since been altered to give effect to the limitations proposed. Sections had been added to the clause by which the local authority might prescribe the route to be taken in their area by the railway omnibuses between the point of arrival and departure of such omnibuses. The clause was opposed by the Corporations of Hull, Newcastle, and Bradford, who, Mr. Moon said, were really speaking for the Municipal Tramways Association. The main question to be discussed was whether the railway company should incidentally carry on a business which would extend the benefits of the railway to places outside the influence of their delivery system, or whether that business should be confined to carrying passengers who had either travelled or were about to travel on the railway system. The question ought to be dealt with in the public interest, and not of either the railway company or the tramway companies. Sir George Gibb, general manager of the railway company, said they had no intention of running those omnibuses except in connection with the railway. The company had lost 53 per cent. of their traffic at some of their stations through tramways, and they were trying to get it back. Mr. Balfour Browne, K.C., on behalf of the opposition of Newcastle, showed how the motor 'buses would affect the Newcastle tramways, on which the Corporation had spent £1,100,000, and then went on to say that Newcastle had offered to negotiate with the promoters. But that offer was made in view of the undertaking given by Sir Edward Grey, and upon the understanding that the bill was intended not to be a competitive bill, but that it was intended for the promotion of the interests of country districts which could not be served at the present time by tramways or by light railways. Had they known that it was to be an absolutely competitive line with them they would have adopted exactly the same attitude as Hull. At the present time Parliament had the greatest difficulty in regulating railways, and had had to establish, because of those huge monopolists, the Railway and Canal Commission for the very purpose of regulating those railways. But there would be no regulation of these motor omnibuses they would be entirely outside the functions of the Railway Commission. It was a serious thing, after Parliament had allowed municipalities to spend large sums of money on tramways, that that company should come and by means of motor 'buses take a great portion of it away. He asked the Committee not to allow any extension of that monopoly.—The Committee decided that the preamble was proved as regarded clause 38 with several alterations. These alterations were to the effect that the local authorities might "from time to time" prescribe the route to be taken in their area by the railway 'buses between the point of arrival and departure of such 'buses, and that any such authority might extend the route beyond those limits; but in the event of any such local authority refusing its consent to an extension, that there should be an appeal to the Board of Trade.—In the House of Commons on June 1 the bill came up for consideration as amended by the Select Committee. (The number of the clause relating to motor omnibuses had been changed to 54.) Mr. Pemberton moved to leave out sub-section (*d*) of clause 54 and to insert instead: "Nothing in this section contained shall authorise the Company, in any city, borough, or other urban district provided with a system of tramways owned or worked by the local authority, to run any railway omnibus otherwise than for the conveyance of railway passengers, passengers' luggage, and mails to or from a station or hotel of the Company, without the consent in writing of the local authority for such period as may be therein specified." He said that where tramways were worked by municipalities subsequent legislation should not allow competition with these tramways. The sub-section which he wished to be omitted would give the railway company power to run motor omnibuses in towns in such a way as to carry pick-up traffic. These 'buses would compete with municipal tramways and bring risk on the rates. The sub-section he wished to be substituted would not prevent the railway company running 'buses in country districts where they were much wanted. Colonel Bowles, chairman of the Select Committee who had considered the bill, defended their action, and said that the Great Eastern Railway Company already possessed similar powers. If a railway company chose, it could promote another company which, without coming to Parliament, could carry out similar powers. The House was quite incompetent to deal with the subject, as it could not hear the evidence or the arguments. It was quite impracticable to prevent passengers in a railway omnibus from getting out of the 'bus before it reached the railway station. The question really was, whether there would be unreasonable competition between the motor 'buses and tramways, and the Committee had decided that in the negative. Mr. Samuel Roberts, on behalf of Sheffield Corporation, supported the amendment, and Sir John Rolleston took the same view for Leicester Corporation. Mr. Yoxall spoke in favour of the amendment from the point of view of Nottingham. Sir James Ferguson deprecated any interference with the decision of the Committee on the bill, and said that the municipalities were protected sufficiently by the clause as it stood. It was not a wholesome principle that municipalities should be allowed not only to enter into this kind of trading, but should be protected by legislation against competition. Mr. Wharton, speaking for the North Eastern Railway Company, said that some members had spoken of the interests of the ratepayers. The North Eastern Railway Company paid £450,000 a year in rates. They had paid for one-sixth of the Newcastle tramways and one-sixth of the Hull tramways. Their object by this clause was simply to assist passengers of the railway to get to their destination. The Company were not seeking for profits. If they were on one side of the ledger more than another last year in connection with motor 'buses, they were on the wrong side. After further discussion, Mr. Bonar Law, Secretary to the Board of Trade, strongly opposed the amendment, and said that the competition spoken of was of little consequence. When it was proposed to run tramways across Westminster Bridge, supporters of the scheme said that there was no possibility of motor 'buses competing with tramways. He was bound to try here to prevent railway companies from being unfairly treated. The drum municipal had been beaten again, but so long as Parliament allowed private enterprise to engage in transit work they were bound to see that companies were allowed to compete on fair terms. He trusted the House would not listen to this municipal influence, for it was beginning to be a question whether this House was to direct the municipalities or whether the municipalities were to control this House. On a division, the amendment was rejected by 127 votes against 110, and the bill was ordered for third reading.

PAISLEY DISTRICT TRAMWAYS. This Provisional Order application was considered on May 5 and 6 by a Commission sitting in Glasgow, under the Scotch Private Legislation Procedure Act

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Mr. Johnston, K.C., for the promoters, said that the object was to get authority to construct extensions of the existing Paisley tramway system, chief of which was a line to Barrhead. It was also sought to extend the time for constructing certain authorised lines and to abandon others. Evidence for the promoters showed the great benefit to the public which had arisen from the Tramways Company having connected Paisley with Renfrew and Johnstone, and the present scheme, it was pointed out, would extend the benefit. Subsequently witnesses were heard for railway companies, who opposed on the ground of competition. It was stated that when electric tramcars began running between Glasgow and Cambuslang, the railway passenger traffic went down by 50 per cent. An adjustment of clauses, however, settled some of the objections of the railway companies. The National Telephone Company claimed that they should recover from the promoters the cost of raising some telephone wires, a work which would be necessitated by the tramway. The Commissioners declined to entertain the claim, and passed the Order.

SOUTHEND AND COLCHESTER LIGHT RAILWAYS.—On June 1 it was intimated to the House of Commons that the opposition to this bill had been withdrawn.

SOUTH LANCASHIRE TRAMWAYS.—Intimation was made to the House of Lords on May 12 that the opposition to this bill had been withdrawn.

WELLINGBOROUGH AND DISTRICT TRAMROADS AND ELECTRICITY SUPPLY.—On May 31 a House of Lords Committee rejected this bill. It was a proposal by the British Electric Traction Company to extend the time for the construction of authorised tramroads, to abandon some authorised lines, and to sanction some new routes. Northamptonshire County Council opposed the bill, and Lord Spencer, who owns land in the district, gave evidence against the measure.

LIGHT RAILWAY APPLICATIONS.

The subjoined half-yearly list of applications to the Light Railway Commission for Orders does not reveal any growth of activity in the promotion of schemes of the kind. There are 18 applications, but only 11 of these propose new lines. Six months ago 12 of the applications asked for construction powers but a year ago there were only 4 applications of the kind. It will be observed that the proposed new mileage is almost equally divided between steam and electric traction; the electric schemes are the more numerous, but individually the lines are shorter than the steam lines. With one or two exceptions the proposals relate to lines in rural districts and among small towns. In reference to the estimates of cost the figure of £890,374 compares with £1,026,039 six months ago, and £217,643 twelve months since. The comparatively great activity of promotion during the first three years' existence of the Light Railways Act has never been equalled since the end of 1899. It is much to be desired that the Government would pass their promised bill to amend the Act and so give promoters greater encouragement to meet the wants of many districts which are poorly supplied with means of communication. One gratifying feature, at all events, about the accompanying list is that in every case it is proposed that the railway should be of standard gauge.

LIGHT RAILWAY COMMISSION APPLICATIONS.

List of Applications made to the Light Railway Commissioners in May, 1905, for Light Railway Orders.

Title.	County.	Promoters.	Engineers.	Mileage.	Motive Power.	Gauge.	Agents.
England.						ft in.	
1. Ackworth	Yorks.	R. E. C Shann and W. F. Tempest	F. H. E. Shipton ..	1¼	Electric	4 8½	Allen, Tennant, and Co.
2. Barking (Extensions)	Essex	Barking Town U.D.C.	W. C. C. Hawtayne, G. A. Zedin ..	¾	Electric	4 8½	H. Hargreaves (Barking).
3. Barton	Lincoln	R. E. C. Shann	F. H. E. Shipton .	11½	Electric	4 8½	Allen, Tennant, and Co.
4. Bath and Lansdown .	Somerset	Projects, Limited	Godden and Co. .	1½	Electric	4 8½	Wilton and Sons (Bath).
5. *a* Bere Alston and Calstock (Amend.) .	——	Plymouth, Devonport, and South Western Junction Railway Co.	Galbraith & Church		—	—	Burchell.
6. Blagdon and Pensford	Somerset	Sir Edward Stachey, Bart., M.P., B. E. Somers, G. D. Armstrong, and others	W. T. Foxlee ..	12¼	Steam	4 8½	F. Wood (Wrington).
7. *b* Derwent Valley (Extension of time) ..	——	Escrick R.D.C. and Riccall D.R.D.C...	——	—	—	—	Lees and Butterworth.
8. *c* Derwent Valley (Transfer, &c.) ..	——	P. C. Hemingway	——		——	—	Lees and Butterworth.
9. *d* Holmfirth and Southowram (Amendment) ..	——	Holmfield and Southowram Light Railway Company	Myers, Beswick, and partners		—	—	Baxter and Co.
10. *e* Leek, Caldon, Low, & Hartington (Amend)	——	Leek and Manifold Light Railway Company	——		—	—	Challinors and Shaw (Leek).
11. North Lindsey (Extension)	Lincoln	North Lindsey Light Railways Company	F. S. Wheat ..	11½	Steam	4 8½	Rees and Freres.
12 *f* North Staffordshire Railway	——	North Staffordshire Railway .	——		——	—	Burchells.
13. Padstow, Bedouthan, and Mawgan ..	——	Padstow, Bedouthan, and Mawgan Light Railways Company ..	——		——	—	Burchells.
14. Ryhope Seaham, Murton, and South Hetton	Durham	S.M.H. Tramway Syndicate, Ltd.	Harper Bros. & Co., D. Balfour & Son	8¼	Electric	4 8½	Torr and Co.
15. Woking and Bagshot (Extension)	Surrey	West Surrey Light Railway Company, Limited	Harrap, Hewitt, and Duffield	1½	Electric	4 8½	Bircham and Co.
16. Wolverhampton and Cannock Chase Railway (Light Railway)	Stafford	Wolverhampton and Cannock Chase Railway Company ..	Sir Douglas Fox and partners, Harper Bros. and Co...	8¾	Electric	4 8½	Paines, Blyth, and Huxtable.
Wales.							
17. Llandilo and Lampeter	Carmarthan and Cardigan	Sir James H. W. Drummond, Brt., Lt.-Gen. Sir James Hill-Johnes, G.C.B., V.C., Lady Elizabeth Hill-Johnes, and others ..	S. W. Yockney, A. L. Yockney ..	23	Steam	4 8½	Morgan, Griffith, Son, and Prosser (Carmarthen).
Scotland.							
18. Falkland	Fife	C. Jackson, J. Lawson, G. Dun, and others	T. Meik and Sons, M. A. Pollard-Urquhart	3¼	Steam	4 8½	W. & W. M. Bell.

Total mileage proposed—93½ miles at an estimated cost (for construction) of £890,374.

(*a*) To acquire additional lands, and to alter gauge. (*b*) To extend time. (*c*) To transfer Order of 1902, etc. (*d*) To extend time and to alter levels. (*e*) To raise additional capital and to extend borrowing powers. (*f*) To authorise certain branch railways to be worked as light railways.

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NEW CONTRACTS AND ORDERS.

Messrs. Milnes, Voss and Company have received an order for six radial trailer cars for the Durban Corporation Tramways.

Burnley Corporation have accepted the tender of Hadfield's Steel Foundry Company, Limited, for a tramrail grinder at £105.

Exeter Corporation have accepted the tender of S. Rawlinson and Sons for a tower wagon for the tramways department at £68.

Messrs. E. Bennis and Company, of Bolton, have received an order from Swinton Town Council for a mechanical stoker and furnace.

Messrs. R. W. Alpine and Sons, of Glasgow, have received the contract for the construction of the permanent way of the West Cumberland Tramways.

The Tempered Spring Company, Limited, of Sheffield, have again had their tender accepted for the supply of all truck springs for the Manchester Corporation Tramways.

Bournemouth Corporation have accepted the tender of Johnson and Phillips for feeder cables, troughing, excavation, etc., for the Christchurch tramways extension at £5,405 16s. 5d.

Messrs. Babcock and Wilcox have received a contract from the Erith Urban District Council for the supply of pipe-work in connection with the tramways plant, at £445.

Belfast Corporation have accepted the tender of Messrs. Courtenay and Company, at £6,281 14s. 5d., for the erection of a pump-house in connection with the generating station.

Messrs. Johnson and Phillips, of Old Charlton, S.E., have received orders for a 400 KW. generator and switchboard extension for the Barking District Council's electricity works.

The British Westinghouse Electric and Manufacturing Company, Limited, have received an order from Greenock Corporation for a 400 KW. steam generator at £2,900.

S. Dixon and Son, Limited, Leeds, have received a repeat order from the West Ham Corporation for 10 sets of Turner's automatic point controllers, to be installed immediately.

Leith Corporation are laying down 6 sets of Turner's automatic point controllers on their new tramways, which are being constructed under the direction of Mr. James More, Junr., consulting engineer.

Southampton Tramways Committee have recommended the Council to accept the tender of Messrs. Griffiths and Company, of London, at £1,711, for re-laying the Portswood Road section of the tramways.

South Shields Corporation have accepted the tender of Messrs. Hurst, Nelson and Company for 10 tramcars at £5,307, subject to the trucks being British made of the Brill standard type, and guaranteed for three years.

Messrs. Gawthorp and Company, of St. George's Sign Works, Leeds, have received a repeat order from the Ashton-under-Lyne Corporation Tramways for their panorama destination indicators, single deck pattern.

Wigan Corporation have accepted the tender of Messrs. Dick, Kerr, and Company for the supply of an engine and dynamo; and those of Messrs. Johnson and Phillips and the British Insulated and Helsby Cables, Limited, for cables.

The Tidswell's Patent Automatic Lifeguard Company have received an order through the Brush Electrical Engineering Company to equip the new cars of the Blackpool, Lytham, and St. Anne's Tramway Company with their lifeguard.

Parr's Electric Point Turner.—The Tramway Committees of Sheffield and Bradford having inspected Parr's electric point turner installed at the junction of Briggate and Duncan Street, in Leeds, have decided to make trial of one of these in each city.

Brighton Corporation have accepted the tender of the British Westinghouse Company for additional switch gear, required at North Road station, at £690, and for supplying isolating switches to all existing feeders and accessories at Southwick station at £1,450.

Messrs. Pritchetts and Gold, of Feltham, have received an order from the Midland Railway Company, for 260 1,210 ampere-hour cells in lead-lined boxes, to work with reversible booster on traction load in connection with the Burton and Ashby Light Railways.

The Public Works Company, of 20, Victoria Street, Westminster, have secured the contract for the laying of "Tarmac" on the Madeira Road, Brighton, which is to be used for the purpose of the speed trials under the auspices of the Automobile Club on July 17, 18, and 19.

Messrs. L. P. Winby and Company, of 20, King William Street, London, E.C., are now fulfilling orders for their patent "Winby" anchor chairs for the following corporations: Aberdeen, Bradford, Bristol, East Ham, and Grimsby, on which tramway systems they have been adopted.

Messrs. H. Lotery and Company, 4 to 8, St. Mary Street, London, N.E., have secured orders for the whole of the uniforms for the Lanarkshire Tramways Company, and for uniform clothing from the Tynemouth and District Electric Traction Company, and the Cheltenham and District Light Railway Company.

Walthamstow Electric Tramways.—In the description of the Walthamstow tramways which appeared in our issue of May 4, it was stated that the Jarrah wood paving was supplied by Millars' Karri and Jarrah Forests, Limited. We have since learned, however, that a large quantity of the wood required was also supplied by Messrs. William Griffiths and Company.

Birmingham Tramways Committee have accepted the following tenders:

Dick, Kerr and Company, reconstruction of permanent way at £42,261 15s. 1d., and 200 tramcars at £110,411 12s.
Bolckow, Vaughan, and Company, tramrails (1,650 tons) and fishplates, at £5 10s. per ton.
Hadfield's Steel Foundry Company, special work at £1,708.

Hudson and Bowring, Limited, of 33, Brazenose Street, Manchester, have received through the Brush Company, a further order for life guards for the Yarmouth cars; and orders for the new cars for Plymouth and Scarborough. Messrs. Hurst, Nelson, and Company, have also ordered "H.B." lifeguards for 12 cars for the Mansfield and District Light Railway, and for 15 cars for Stalybridge.

Pearson, Huggins, and Company, Limited, of Eastville, Bristol, and 51, Scrutton Street, London, E.C., have secured contracts for the supply of uniforms for the Bexley Heath Tramways, the City of Carlisle Electric Tramways, the Wolverhampton Corporation Tramways, and the Gravesend and Northfleet Electric Traction. They have orders also from Lancaster, Ipswich, East Ham, Rothesay, Weston-super-Mare, Pontypridd, and Taunton Tramways.

Huddersfield Corporation have accepted the following tenders in connection with the Tramways Department:

Trolley heads—Fleming, Birkby, and Goodall, Limited.
Trolley wheels—T. Philipps, Sons and Company.
Ears and frogs, trolley, span and guard-wire—British Thomson-Houston Company.
Anti-friction metal—Glacier Anti-Friction Metal Company.
Car wheels—British Griffin Chilled Iron and Steel Company.
Air gap section insulators—Electric Tramway Equipment Company.

Rural Tramways, Buenos Aires.—Messrs. J. G. White and Company, of 22a, College Hill, Cannon Street, London, E.C., have closed a contract with the Rural Tramways, Buenos Aires, for the supply and erection of 35 miles of overhead electric tramway equipment. The contract includes the supplying and laying of the cables required, about 100 cars and equipments, and the erection and equipment of a power-house with a capacity of 2,000 KW. The amount of the contract is approximately £250,000. The work of construction will be begun in the autumn.

Railway Motor Vehicles.—The London, Brighton and South Coast Railway Company will run a frequent service of motor vehicles between Hastings and Eastbourne during the summer, and have given contracts for two steam motor-cars to Messrs. Beyer, Peacock, and Company, of Gorton, Manchester, and for two large petrol-driven rail cars to Messrs. Dick, Kerr, and Company, of Preston. The latter vehicles each accommodating fifty passengers, will be fitted with engines provided by the Daimler Motor Company, of Coventry, capable of developing 36 horse-power and giving a normal speed of 30 and a maximum speed of 55 miles per hour.

The National Electric Construction Company, Limited, have secured the contract for the construction of the Mexborough, Rawmarsh, and Swinton Tramways. This contract includes the building of the generating station and car sheds, and the construction of generating plant, cars, permanent way, and cables; also feeders and distributors for lighting Swinton and Rawmarsh. The company have also secured the contract for laying the permanent way, feeders, and cars for the Torquay tramways. The total amount in all is approximately £300,000. The former contract will be started shortly, and operations will commence on the latter during August next.

Batley Electric Tramways.—The Batley Corporation Tramways Committee on May 17 considered tenders for the laying of the double line of tramways in Bradford Road, and the erection of the overhead electrical equipment. After considerable discussion it was decided to accept the tender of Messrs. Dick, Kerr and Company for the laying of the metals and the erection of the standards and overhead wires. The paving will be done by the Corporation. Messrs. Dick, Kerr and Company have now obtained the contracts for the laying of the whole of the double set of rails from Dewsbury Market Place to Birkenshaw, and it is expected that the work will be commenced immediately. It is expected that electric cars will be running on some parts of the route by the end of August.

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Birmingham Corporation have received the following tenders for the reconstruction of the Aston Manor Tramways. The figures quoted are the net amounts after deducting the value of old materials:

Geo. Trentham (*accepted*)	£51,236	3	9
Dick, Kerr and Company, Limited	51,849	1	10
Geo. Law	52,912	7	6
J. G. White and Company, Limited	52,357	15	9
Underwood and Brother	53,387	7	6
Griffiths and Company, Limited	54,073	9	6
Graham and Sons	54,162	0	0
Krauss and Son	56,552	5	0
John White, Jun.	59,112	7	7
Geo. Holloway	61,572	5	0
R. W. Blackwell and Company, Limited	61,785	12	0

The Brush Electrical Engineering Company, Limited, have recently closed the following contracts:

300 KW. steam dynamo switchboard extensions, for the Merthyr Electric Traction and Lighting Company.

Six double-deck 4-wheel cars, with Raworth regenerative control equipments, for Plymouth Corporation.

Twenty single-deck composite motor cars, mounted on radial trucks, for the North Metropolitan Electric Tramways Company.

Ten double-deck 4-wheel car bodies, for Stockport, through the British Thomson-Houston Company.

50 KW. steam dynamo set, for Leicester Corporation.

Two 1,000 KW. steam turbo-alternators, for the North Metropolitan Electric Power Distribution Company, near Willesden.

Four tramcars with radial trucks, for Derby Corporation.

Five double-deck 4-wheel car bodies, with Brush standard trucks, for Lanarkshire Tramways, through the British Thomson-Houston Company.

Forty-five standard Brush trucks, four-wheel, for Belfast Corporation.

Six electric cars with trucks and Brush motor equipments for Taunton and West Somerset Tramways Company.

Thirteen double-deck four-wheel car bodies with standard Brush trucks and Westinghouse equipments, for the Midland Railway.

Ten double-deck four-wheel car bodies, mounted on radial trucks, for Blackpool, St. Anne's, and Lytham Tramways, through the British Thomson-Houston Company.

PERSONAL.

Mr. William H. Brown has been elected a director of the London United Tramways.

Lord George Hamilton, M.P., has been elected a director of the Metropolitan District Railway Company.

Mr. W. G. Snell, tramways inspector, has been appointed traffic superintendent of the Perth Corporation Tramways.

Mr. G. E. Heath, electrical engineer to the Erith District Council, is to have his salary increased from £200 to £250 per annum.

Mr. R. J. Williams has been appointed power-station superintendent to the Sheffield Corporation Tramways Department.

Mr. R. D. McCarter, Junr., the Bath Electric Tramways manager and engineer, has been appointed general manager of the Sunderland and District Tramways Company.

Mr. D. Driver, the energetic chairman of the Keighley Tramways Committee, has temporarily assumed control of the tramways undertaking, pending the appointment of a manager.

Mr. A. N. Moore, assistant engineer at Stuart Street Station, Manchester, has been appointed superintendent of the old and new generating stations at Belfast.

Mr. Philip U. Askham, who was well-known to tramway men as for many years the head of Messrs. Askham Brothers and Wilson, Limited, died on the 24th ult. after a long illness.

Mr. Percy A. Postlethwaite, mineral and metallurgical chemist, who of late years was an analyst with the Hadfield Steel Foundry Company, Limited, Sheffield, has removed his offices to 2, Union Court, Old Broad Street, E.C.

Mr. T. P. Wilmshurst, borough electrical engineer to Derby Corporation, has been granted an increase of salary from £500 to £550 per annum, as from May 1, with a further rise of £50 from May 1, 1906.

Mr. Robert Birkett, the Burnley borough electrical engineer, has been appointed electrical engineer and general manager of the Southend-on-Sea Corporation Tramways. After several years' service, Mr. Birkett tendered his resignation to Burnley Town Council on May 17.

Mr. William Bain, who has been acting as constructional engineer, and later as interim manager and engineer of the new Musselburgh Electric Tramways, has now been appointed manager and engineer of the undertaking. Mr. Bain was for a number of years in the service of the National Electric Construction Company in Lincoln and Greenock.

Mr. J. Christie, engineer and manager of the Brighton Corporation Electricity Department, has been granted an increase of salary from £500 to £750 per annum. Since Mr. Christie went to Brighton, some five years ago, the electric supply undertaking has practically doubled its business. His services have been secured by the Council for the next six years certain.

Mr. Charles James Cater-Scott, chairman of the London and India Docks Company, has been elected a director and appointed chairman of the London United Tramways. Mr. Charles T. Yerkes, it will be remenbered, announced his intention some time ago of retiring from the chairmanship in order to devote more of his time to the Metropolitan District Railway Company.

Mr. Hilliard Stephens, of 39, Victoria Street, has been appointed sole London agent for the Asphaltic Limestone Concrete Company, Limited, direct importers and refiners of Trinidad bitumen. Mr. Stephens has also been appointed agent to Messrs. A. and J. Main and Company, Limited, structural engineers, Glasgow and London. All communications should be addressed to 39, Victoria Street.

Mr. Ernest Moore, chief assistant clerk of the Sheffield Corporation Tramways Department, who has recently been appointed to the position of chief clerk of the Halifax Corporation Tramways, was presented on May 15 by his late colleagues with a solid gold albert and seal, as a token of their esteem. Mr. Moore has been connected with the Halifax Tramways during the last eight years.

Mr. Arnold B. Gridley, who for the past four years has been secretary of some of the associated companies of the B.E.T., has accepted an important position on the staff of the Newcastle Electric Supply Company. Mr. Gridley was presented with a canteen of plate and cutlery by the directors and staff of the British Electric Traction Company. The presentation was made by Mr. Garcke.

Mr. Alfred Baker, general manager of the Birmingham Corporation Tramways, and president of the Municipal Tramways Association, has been appointed by the Board of Trade to inquire into and report upon the terms of a proposed agreement between the Rhondda Urban District Council and a company (to be formed) for the lease of the tramways for a period of years, authorised by the Rhondda Urban District Council (Tramways, etc.) Act, 1902. Mr. Baker will hold a local inquiry at an early date, at which ratepayers and others will have an opportunity of stating their objections.

Mr. J. K. North, general manager of Rossendale Tramways, is one of the few tramway managers who still have charge of steam locomotives. His engines are not of very recent construction, but they are made to perform their work in a way that suggests that Mr. North thoroughly understands steam locomotion and its capabilities. The receipts average about 1s. per mile, and the total expenses do not exceed 8d. The result is a substantial dividend for the shareholders, who owe much to their manager for keeping the expenses at a figure that some electric tramways considerably exceed.

Mr. Sidney C. Sheppard has resigned his position on the staff of the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board and is leaving to take up an important position under the Bolivian Government in about two months' time. Mr. Sheppard will be glad to receive catalogues and notices of specialities with reference to electrical plant of all kinds, and especially to tramway and railway traction work. All communications should be addressed to Mr. Sheppard, c/o. Mr. E. E. Abrahamson, 14, Wormwood Street, Old Broad Street, E.C.

Mr. A. L. C. Fell, manager of the London County Council Tramways, has returned from his visit to the United States. Amongst other cities, he visited New York, Washington, Pittsburg, Buffalo, and Niagara, and expresses himself as deeply interested in all he saw in connection with tramways. To a representative of the press he remarked that his finest experience was a ride on an electric locomotive, which beat one of the fastest trains on the Great Central Railway. "Of course," he continued, "they have tramways everywhere, chiefly on the overhead system. The only cities using the conduit system are Washington and New York, and that was what I went out principally to see. I think, however, we have quite as good a system in London. Naturally, we have taken their good ideas from time to time, and in the report I shall present to my Committee I may have some suggestions to make for London as a result of what I have seen across the water."

Mr. James Dalrymple, general manager of the Glasgow Corporation Tramways, left Liverpool on May 20 by the *Campania*, for Chicago. Mr. Dalrymple is proceeding to Chicago on the invitation of Mr. Dunne, the Mayor of that city, in order to assist with his advice in regard to the possible municipalisation of the Chicago tramways. Mr. Dalrymple, who is a member of the committee of the Electric Tramway and Railway Exhibition, hopes to return in time for the opening of the Exhibition on July 3.—On May 27 Mr. Dalrymple arrived in New York, where he was met by several members of the Municipal Ownership League of Chicago, who came from that city to welcome him, and also by a deputation of New York city officials. On being asked his opinion of the tramway systems of New York, Mr. Dalrymple criticised them severely. He did not think they were worthy of a great city, and declared that they were not nearly so good as Glasgow possessed. Much of this criticism was directed to the lack of discipline on the part of the tramway employees there.

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FINANCIAL REPORTS.

The Electric Railway and Tramway Carriage Works, of Preston, at a meeting on May 18, decided to acquire the Castle Car Works, Hadley, Salop, and the British Electric Car Works, Old Trafford, Manchester. The purchase price is said to be £85,000.

The S.M.H. Tramway Syndicate, Limited, was registered on May 17, with a capital of £1,000 in £1 shares. Its object is to apply for powers to construct light railways or tramways in Durham; to equip, maintain, and work the same by means of electrical, steam, animal, or other power, and to carry on the business of tramway, railway, omnibus, motor-car, van, and mechanical carriage proprietors, suppliers of electricity for power and light, etc. The registered office is at 13, St. Helen's Place, E.C.

Mexborough and Rawmarsh Construction Syndicate, Limited.—This company was registered on May 13, with a capital of £175,000 in £1 shares. Objects: To adopt an agreement with the National Electric Construction Syndicate, Limited, to construct, lay down, and carry out all necessary cables, wires, stations, lines, accumulators, dynamos, etc.; and to carry on the business of railway and tramway proprietors, suppliers of electric light and power, etc. Registered offices, 34, Victoria Street, S.W.

Bradford Corporation Tramways.—At a meeting of the Tramways Committee, on May 29, the city treasurer reported a profit of £70,000 on the tramways undertaking, and stated that, after the repayment, by means of the sinking fund, of a thirtieth of the capital of nearly a million pounds and interest averaging nearly 3½ per cent. on the remainder of the capital, there remained a disposable balance of £16,000. This is the largest balance which the Committee has had. The increase is attributed to the local exhibition and the policy of the Committee, which has been to extend the system and to reduce fares.

Halifax Corporation Tramways.—A financial statement showing the working results of the Tramways Department for the twelve months ended March 31 last has been presented to the Town Council. The receipts amounted to £74,521 19s. 1d., and the expenditure to £73,532 11s. 1d., leaving a profit of £989 8s., as compared with a profit of £493 8s. 7d. in the previous twelve months. At the beginning of the year it was estimated that the surplus would be only £486. The increase is due to a slightly advanced income and a small decrease in expenditure. The whole of this year's profits will be appropriated for depreciation

Northampton Corporation Tramways.—A balance sheet of the tramway undertaking for the year ended March 31 last has been presented to the Town Council. The total receipts were £16,869, and the expenditure on working £9,612, leaving a gross profit of £7,257. To this is added £201 brought forward from March, 1904, and interest £40, making a balance of £7,499, which has been disposed of as follows: Towards repayment of loans, £2,652; interest on loans, £3,757; preliminary expenses, £105; reserve for third party risks, £233; and general reserve fund, £751. The tramways were worked electrically during eight months of the financial year.

Birmingham Corporation Tramways.—The Tramways Committee report that the gross profit on the Steelhouse Lane route amounts to £6,784, and after providing for interest on capital and contribution to sinking fund, there remains a net profit of £5,800, which the Committee have carried to the reserve fund account, which now stands at £6,483. The electrification of four other routes is to be taken in hand at once. Tenders have been accepted for 1,650 tons of tram rails, with the necessary number of fishplates, at £5 10s. per ton; for special tramway work, £1,708; for reconstructing permanent way, £42,251; and for 200 electric cars, including provision of spare parts and contingencies, £110,411.

Burton Corporation Tramways.—The report of the working of the Burton Corporation Tramways for the year ended March 31, was presented to the Town Council on May 10. The amount expended on capital account reached the sum of £86,012 13s. 11d. The number of passengers carried was 3,878,269, and the traffic receipts per car mile were 9·21d. The maximum number of passengers carried any one day was 24,885, and the receipts £125 4s. The gross revenue account for the year showed a surplus of income over expenditure of £5,160 19s. 5d., of which £4,604 0s. 7d. was absorbed in repayment of debt and interest, leaving a balance of £556 18s. 10d., which it is proposed to carry to repairs and renewal fund.

Carthagena and Herrerias Steam Tramways.—The report for 1904 shows gross traffic of £39,907 and a surplus of £1,258, which, added to the sum brought forward, gives £3,300 at the credit of revenue account. It is proposed to pay a dividend at the rate of 2 per cent., or 4s. per share, carrying forward £300. The branch to the public wharf in the port of Carthagena, which was opened to traffic in January of last year, has proved a great help to the company in the bad year passed through, and is a distinct benefit to local commerce. On the extension to Los Blancos the total tonnage carried was 107,386, against 102,920 in 1903, but the revenue of the extension did not suffice for any distribution to this company. No dividend was paid for 1903

Callender's Cable and Construction Company. Including £24,581 brought forward, the profit for the past year amounted to £81,646. The directors set aside £12,336 for depreciation, and write off £2,777 to extinguish the balance of cost of the issue of debenture stock, after which dividends and a bonus amounting in all to 12s. 6d. per share are declared, leaving £23,406 to be carried forward. The stringency of the money market and the resulting inability of local authorities and others to obtain capital for new works have of necessity restricted the company's trade in all parts of the United Kingdom. During the past year a considerable extension of the company's business has taken place abroad, especially in the East. Cable-laying contracts have been completed or are in progress in Bombay, Calcutta, Kandy, Penang, Kuala, Lumpur, Singapore, and Hong Kong, whilst further orders are now in course of execution for Bangkok and the Kidderpore Docks. Contracts have also been carried out in New Zealand at Wellington and Dunedin. Considerable orders have been executed in Mexico, and the company's staff is now cable-laying in the Argentine.

Blackburn Tramways. At a meeting of the Electricity and Tramways Committee on May 22, the annual reports of the two departments were submitted. The statements cover the year ending March 25 last. The total revenue of the tramways is £48,875 0s. 0½d., and the working expenses amount to £30,580 9s. 8d., leaving a gross profit of £18,294 16s. 4½d. Interest on loans swallowed up £8,599 8s. 11d. and £12,488 3s. 1d. was placed to the sinking fund account, with the result that the gross profit was turned into a deficit for the year of £2,792 15s. 7½d. According to the traffic returns the total number of passengers carried was 8,661,720, the receipts per car mile being 11·46d. as against 10·94d for 1904 and 11·89d. for 1903. The year's income for the Electricity Department was £28,247, and the expenditure £13,699, leaving a gross profit of £14,548. Of this £14,297 was devoted to interest and sinking fund, leaving a net profit of £251, as compared with £1,634 last year. The number of units sold during the year for all purposes increased from 2,895,181 to 3,129,215, the works cost of which has been reduced to ·63d. per unit sold. Blackburn is the ninth on the list of the 180 stations in the United Kingdom for low cost for production of electricity.

Reading Corporation Tramways.—A report has been submitted to the Tramways Committee showing the working results of the Tramways Department during the year ended March 31 last. The number of passengers carried was 7,642,147. The number of miles run by the cars was 872,426 and the traffic receipts per car mile amounted to 8·98 pence, or ·97 of a penny per passenger carried. The total traffic receipts amounted to £32,650 10s. 1d. The consumption of electric current per car mile was 1·02 units; 1,020,400 units have been generated during the year, the works cost per unit being ·74d., as against ·85d. during the first 8¼ months of electric traction from July 22, 1903, to March 31, 1904. The total receipts from all sources amounted to £33,573 4s. 10d. The total working expenses amounted to £18,892 9s. 8d., leaving a gross profit of £14,130 15s. 2d. Interest and sinking fund absorb £11,757 0s. 2d., leaving a net profit on this year's working of £2,923 15s., which with a balance of £618 10s. 4d. brought forward from last year leaves £3,542 5s. 4d. available for appropriation. The tramways manager recommends that this be placed to a reserve or renewals fund account to meet the heavier items of expenditure which will arise as time goes on consequent on the depreciation of the equipment.

Brush Electrical Engineering Company.—Presiding at the annual meeting at Salisbury House on May 10, Lord Vaux of Harrowden said that they were able to report an increased turn-over, due not to abnormal influences, but to unremitting care and hard work. Large rolling stock orders had been executed, and they had delivered to the Metropolitan District Railway cars and trucks representing the highest class of electrical railway vehicles yet constructed. In view of the electrification of other railways they had made preparations for handling large orders of this description. Special plant had been laid down for constructing cars that would not catch fire. In the manufacture of tramcars the company still held the foremost position, and they anticipated a ready sale for their new radial axle trucks. The net profit for the year was practically the same as last year. With regard to developments the chairman said that they looked to the evolution of the automobile to prove a useful auxiliary to tramways and light railways. They were therefore building motor 'buses of this class. In addition to an all-steel railway car they had a new type of reciprocating engine, also radial trucks for tramcars, and an ingenious form of coal-cutting machine for mines. Mr. W. Madgen seconded the adoption of the report, which was agreed to.

Sunderland District Electric Tramways, Limited. The report for the year ended March 31 last states that during the year the work of construction of this company's tramways has been proceeded with, and the first section is now completed. The construction has been unavoidably delayed by protracted negotiations in connection

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with road widenings, but nearly all the difficulties in connection with these have been practically overcome. The power-station is in course of erection and is nearly completed. It is expected that the second section of the tramways from Houghton-le-Spring to South Hetton will shortly be constructed, the company having made financial arrangements to meet the outlay upon the construction of this section, and a large amount of the calls in arrear at the date of the balance-sheet having been since collected. The directors have entered into a contract with the Durham Collieries Electric Power Company, Limited, whereby that company operate under rent and royalty the right to supply electric light and power in the district covered by this company's orders, and, at the same time, they have further arranged with the same company to supply the Sunderland District Tramways, Limited, with the power necessary for driving their electric plant for the operation of the tramways.

Leeds Corporation Tramways.—At a meeting of the Tramways Committee of the Leeds Corporation, held on May 1, the general manager, Mr. J. B. Hamilton, submitted a statement with regard to the revenue and expenses for the year ended March 25 last. The total revenue amounted to £298,233 7s. 5d., which worked out at 10·15d. per car-mile run. The car-mileage run was 7,044,838, as compared with a mileage of 6,091,407 in the previous year, and accounted to a considerable extent for the reduction in the earnings per car-mile, which a year ago amounted to 11·05d. The traffic expenses were £83,005 12s. 2d., as against £79,869 11s. 1d., an increase of 4 per cent. The cost per car-mile, owing to the improved traffic arrangements, had been reduced from 3·15d. to 2·82d., representing a saving in the working expenses of over £9,000. The total working expenses amounted to £161,297 3s. 7d., leaving a gross profit of £136,936 3s. 10d. From this had to be deducted £31,691 10s. 5d., fixed charges for interest on capital outlay, £28,501 13s. for redemption fund, and £21,743 0s. 5d. for income tax and depreciation, leaving £55,000, which the committee resolved to pay over to the Finance Committee to be applied in relief of the rates. Last year the total revenue was £280,562 16s. 3d., and the expenditure £148,821 12s. 5d., leaving a gross profit of £131,741 3s. 10d., of which sum £52,000 was applied to the relief of the rates.

Bournemouth and Poole Tramways Purchase.—At a meeting of the Bournemouth Corporation Tramways Committee, the town clerk reported that the umpire (Mr. Justice Lawrence) had now certified that the portion of the award of £112,000 which was allocated to the Poole tramways undertaking, and powers to be purchased by Poole and Branksome, was £108,900, thus leaving £4,000 for the Christchurch powers, in addition to the agreed sums of £5,500 and £350 (or £9,850). He further reported that the £108,000 included the rolling stock, which was, according to the agreement, to be purchased by the Corporation, and which the borough engineer valued at £8,000, so that the Poole and Branksome authorities would in the result have to pay £100,000, and as the agreement stipulated that the purchase money was to be paid in equal shares, £50,000 would have to be paid by each authority, which sum each had applied to the Board of Trade for sanction to borrow. The sum payable by Bournemouth Corporation was therefore in addition to the costs of the arbitration (not yet ascertained) £9,850 plus £8,000 £17,850. He stated that the two draft conveyances had been submitted to the company's solicitor for approval, the consideration moneys insisted upon being £100,000 and £17,850 respectively, and reported his correspondence with the company's solicitor up to date. The town clerk was directed to carry the matter through on the lines proposed, and general instructions were also given to him on the subject.

Worcester Electric Traction Company.—The report for the year ended December 31 last, states that the capital expenditure amounted to £114,319 13s. 8d., of which £38,329 8s. 3d. was incurred during the year. A further £1,200 debenture stock and £18,000 in ordinary shares have been allotted, and the directors propose to issue a further £25,000 debenture stock and £35,000 in ordinary shares in order to provide moneys for the discharge of the liabilities in connection with the construction and equipment of the lines. The total revenue for the year amounted to £15,611 2s. 10d. After deducting all expenses chargeable to revenue, including repairs, maintenance, and debenture interest, and adding the balance brought forward from last account—viz., £523 7s. 8d., there remains an amount of £5,216 10s. 6d. available for allocation. The directors recommend that this should be applied as follows: To be placed to depreciation and reserve fund £1,500, to pay dividend on the 8,000 ordinary shares at the rate of five per cent. per annum £2 000, to be carried forward to next account £1,716 10s. 6d. Having regard to the fact that only a portion of the system was opened for electric traction on February 6, and that the whole of the lines were not in operation until June 20, the directors consider the result is satisfactory. The following details are included in the report: Route miles, 5·75; route miles worked by 'buses, 20; number of passengers carried, 3,102,352; average traffic receipts per passenger, 1·18d.; average expenditure per passenger, 0·81d.; proportion of expense to receipts, 68 per cent.; number of cars in stock, 15; number of 'buses in stock, 10.

Bournemouth Corporation Tramways.—Mr. C. Barber, the tramways manager, has presented a report on the tramways undertaking for the year ending March 31 last. The total income amounted to £56,323 14s. 9d. (12·05d. per car mile), and the working expenses to £33,592 13s. 10d. (7·19d. per car mile), leaving a gross balance of £22,731 0s. 11d. (4·86d. per car mile), which, compared with that at the end of the financial year ended March 31, 1904, shows a decrease of £1,389 15s. 2d. As a result of a more frequent service of cars having been given at certain periods, the mileage run has been 1,121,623, compared with 1,022,163, being an increase of 99,460 miles. At the same time the number of passengers carried has been 10,058,288, equivalent to the population being carried 167 times, and is an increase of 694,303 passengers as compared with last year. The traffic receipts have increased £2,830 16s. 8d. on the gross, but the receipts for the extra miles run are only equivalent to 6·83d. per car mile. The working expenses for the year amounted to £33,592 13s. 10d., as against £29,277 18s. 2d. for last year, an increase of £4,314 15s. 8d. The percentage of working expenses to receipts was 59·64 per cent., as against 54·82 per cent. last year, an increase of 4·82 per cent. Notwithstanding this increase and the fact that the system is the only combined trolley and conduit system in the kingdom, the figure is well below the average of other systems as shown by published reports. An average of 47 local authorities' returns for the financial year of 1904 shows a figure of 67·4 per cent. for the percentage of working expenses to receipts.

South Staffordshire Tramways Company.—The report for the half-year ended December 31 last, states that the total revenue for the half-year amounted to £1,257. After deducting all expenses chargeable to revenue, there remains a profit of £663; which, added to the amount of £7 brought forward from the last account, gives an available balance of £670. The directors recommend a dividend of 1s. 8d. per share on the preference shares for the half-year, leaving to be carried forward £37. A settlement has now been arrived at with the South Staffordshire Tramways (Lessee) Company, Limited, with regard to the repayments for reconstruction under the terms of the lease, which is embodied in the draft agreement. The amount to be repaid for the work already carried out in respect of which that company claims £18,500 has been fixed at £11,500. Negotiations are still pending with the Corporation of Dudley regarding the purchase of the lines within their area.—An extraordinary meeting was held in London on May 22, when Mr. C. O. B. Fulton, the chairman of the company, moved resolutions formally approving of a contract for selling a portion of the company's undertaking to the Corporation of Wednesbury; also an agreement between this company and the South Staffordshire Tramways (Lessee) Company, the particulars of which had been previously submitted to the shareholders. The chairman explained that this agreement had been arrived at as the result of a compromise. There was a possible claim against the company of £55,000, which had practically been reduced to £35,000. This amount would be gained by this company in the event of the "lessee" company carrying out the reconstruction of the line. At the next meeting he hoped to submit agreements for the reconstruction of the Tipton and several other lines. After the sale of various portions of the lines to the borough corporation the remainder would be worked by the "lessee" company. The resolutions were carried, and the accounts were then submitted to the ordinary general meeting. The chairman in moving their adoption, said that with the exception of a small room at Wednesbury the offices would be transferred to the British Electric Traction Company's offices in London, and the directors' fees would be reduced from £600 to £100. The report was adopted.

PROGRESS UNDER THE LIGHT RAILWAYS ACT.

In the House of Commons on May 18,

Mr. Griffith Boscawen asked the Secretary to the Board of Trade if he could state how many light railways had been authorised to be constructed under the Light Railways Act, how many had actually been constructed, what was the annual cost of the Light Railway Commission, and whether it was proposed to renew the Act or to allow it to terminate.

Mr. Bonar Law, in reply, said: The length of lines authorised as light railways under the Light Railways Act up to the present date is 1,567 miles, and 429 miles have been constructed and opened for traffic. The cost of the Light Railway Commission in the financial year 1903-4 was £3,647, and from the commencement of the Act to the end of that year it was £22,991. Some additional expense is incurred by the Board of Trade in dealing with Orders made and submitted to them. The total amount received in fees under the Act to March 31, 1904, was £22,750. Proposals for amending and continuing the Act are now before this House.

The J. G. Brill Company has recently booked an order from the Metropolitan Street Railway, New York City, for seventy-five 28 ft closed cars, to be mounted on the builders' patented "Eureka" maximum-traction trucks. The cars will be duplicates, in all details, of those of former large orders filled by this company.

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TRAMWAY AND LIGHT RAILWAY NOTES.

ABERDEEN.—Judgment was given by Lord Low in the Court of Session, on May 31, in an action in which the Great North of Scotland Railway Company sued Aberdeen Corporation to have defenders interdicted from maintaining a tramway junction at less than a certain distance from the pavement in front of pursuers' property in Union Street and Bridge Street, and making any alterations so as to diminish the pavement. Decree of restoration was also asked, or alternately, £3,000. His lordship held that defenders were not entitled to construct a tramway junction so that any rail should be nearer than nine feet six inches to the outside of the footpaths *ex adverso* of pursuers' property, or to diminish the width of the footpaths. He therefore granted interdict, and ordained defenders to restore the footpaths in Bridge Street and Union Street to their former condition, pusuers being found entitled to expenses.

ARDROSSAN.—Ayrshire County Council have appointed a committee to consider a proposal for the construction of a tramway between Ardrossan and Stevenston.

BATH.—Sir Vincent Caillard stated at the annual meeting of the Bath Electric Tramways Company that it had been decided to adopt motor omnibuses to feed the tramways and to penetrate into the neighbouring country in search of traffic. He hoped to see six motor omnibuses running in July.—The Light Railway Commissioners are being applied to by "Projects," Limited, to sanction a rack railway from Weston to Lansdown. The motive power will be electricity. There will be a junction with the present terminus of the Bath Electric Tramway Company, and the ascent of the hill will be made through fields to the down, where the station will be near the racecourse. There are said to be no engineering difficulties A capital of £15,000 will be raised.

BELFAST. A new motor mail service, the first to be introduced into Ireland, was inaugurated on the Belfast and County Down system on May 1, between Belfast and Holywood. The new service has been instituted primarily to compete with the prospective electric tram system. There are three convenient stopping stages in the five miles between the two towns. A similar service will shortly be in operation on the Midland line, on the other side of Belfast Lough. At a meeting of Belfast Tramways and Electricity Committee on May 1, Mr. Nance submitted a letter from the Board of Trade expressing entire satisfaction with the design and details of the cars which had been built for the Corporation. He further reported that the service he intended to put on when the tramways were electrified would require 173 cars running daily. He proposed to convert 25 of the best of the existing cars and to obtain prices, for the consideration of the Committee at the next meeting, for 30 cars from the Brush Company.—At a meeting of the Committee on May 8, Mr. Nance intimated his wish to have 50 of the old cars reconstructed in Belfast, and assured the Committee that they might be made equal to the new cars, and with considerable saving. Permission for this experiment was granted by the Committee. The borough surveyor reported that the work in connection with the electrification of the tramways was proceeding satisfactorily. The manager stated that in the last sale of tramway horses the average price received was £12 4s. 8d. per horse. A letter was read from the British Electric Traction Company suggesting that for current for the Cavehill and Whitewell Tramways they should only be charged 1½d. per unit, with a minimum of 150,000 units, but the Committee decided that they could not alter the proposal they had already made to the company.

DONCASTER.—A plebiscite has been taken on the question of Sunday running. Those in favour numbered 564, while the votes against amounted to 1,536.

EDINBURGH.—The Town Council are considering the merits of the various surface-contact traction systems in view of the projected electric tramways. On May 11 the Lord Provost's Committee received representatives from the Dolter, Kingsland, and "G.B." Companies, who explained the working of their systems. During the meeting Professor Kennedy, the electrical adviser to the Corporation, was present.

GREENOCK.—Negotiations between Greenock Corporation and the Greenock and Port Glasgow Tramway Company with respect to terms for a supply of electricity for the next five years from Whitsunday have been brought to a satisfactory conclusion. According to the agreement, the company guarantees a minimum annual consumption of 500,000 units, and the payment is to be at the following rates: First 500,000 units, at 1·5d. per unit; next 200,000 units, 1·25d. per unit; next 200,000 units, 1·00d. per unit; and all units per annum consumed in excess of 900,000 units, 0·85d. per unit. The maximum demand is not to exceed 660 KW.

HALIFAX.—At a meeting of Halifax Corporation Tramways Committee, on May 25, a letter was read from the Board of Trade stating that the Board are not empowered to give, either by provisional order under the Tramway Act, 1870, or otherwise, authority to enable the Corporation to carry out a proposal to run motor omnibuses between Halifax and Wainstalls.

LEITH.—The Corporation tramways, of which Mr. James More, Junr., is consulting engineer, and which are now under construction, will consist of twelve miles of track, extending through six miles of street. The tramways are standard gauge. A rail of heavier weight than usual, viz., 106·7 lb., is being used, and the rails are secured with Dicker joints, and are being bonded with Forest City bonds. The maximum gradient is 1 in 19, and the sharpest curve has a radius of 54 ft. 0000 grooved trolley wire, supplied by the British Insulated and Helsby Cables, Limited, is being used. The fittings have been supplied by S. Dixon and Son, Limited, of Leeds. 36 double-deck single-truck cars, all supplied with top covers, are under construction; 18 of the cars are being supplied by the Brush Company and 18 by the Electric Railway and Tramway Carriage Works. The trucks are of the Brill and Brush type 18 of the cars are equipped with Brush motors and controllers, and 18 with the British Thomson-Houston equipments. Current for working the cars will be supplied from the Corporation's lighting station at a price to be agreed upon later.

LLANGOLLEN.—On May 15 the Llangollen Engineering Bus Syndicate inaugurated a road motor service between Llangollen and Bettwys-y-coed. The trial trip was essayed with a new motor, accommodating sixteen passengers. The syndicate directorate party included Sir Henry Robertson and Sir Watkin Wynn. The new service will ensure expeditious routes to Bettwys-y-coed for holiday seekers, and will develop an extensive agricultural district. Tested on several difficult gradients the car gave every satisfaction, covering the 70 miles on the double journey without mishap. It is a 22 H.P. two-cylinder car, built by the Wolseley Company, Birmingham.

LONDON. In order to meet the competition of the London County Council tramways, the City and South London Electric Railway has made considerable reductions in fares, particularly in return fares.—In the Chancery Division on May 20, before Mr. Justice Warrington, the Mayor, Aldermen, and Councillors of the Metropolitan borough of Wandsworth sought for an injunction to restrain the London United Tramways (1901), Limited, from breaking up roads and streets within the borough of Wandsworth. It appeared that the company's Acts authorised the construction of electric tramways from Surbiton to Kingston and Wimbledon, with connections and generating stations. The tramways go through no part of Wandsworth, but the company desires to obtain electrical power from a generating station in Chelsea. With that object in view the company intended to lay mains through Wandsworth. This the plaintiffs contended the company was not authorised to do under its special Acts. The defendants, on the other hand, submitted that the Act referred to did not confine the company to its own generating stations and connections, but included public generating stations. The Act therefore authorised the company to interfere with streets, roads, bridges, and rivers outside the district through which the tramways were to be laid. His Lordship said he could not put the construction on the Acts which the plaintiffs asked the Court to do, and he must therefore give judgment for the defendants. It was subsequently arranged between the parties that the matter should be adjourned for the purpose of the plaintiffs considering whether they would treat the matter as the trial of the action, and so end the matter, or whether they would appeal.

MANCHESTER.—A deputation from the City Council of Detroit visited Manchester recently in order to inquire into the working of the tramway system. A movement is on foot to municipalise the Detroit tramways, and it has been decided to collect information on the subject. The deputation were much impressed by their visit to the Manchester Corporation Tramways, and were especially gratified at the financial results, and at the absence of jobbery, which they regard as a serious danger to municipal enterprises on their side.—A project is on foot for promoting a bill in next session of Parliament seeking powers to construct a South Manchester Electric Railway to connect the outer Cheshire suburbs and the city. The proposed railway will be an express suburban cross-country "belt line," of standard gauge and constructed as a light railway, the main line being about 16½ miles long, and the branches bringing the total mileage up to about 26 miles. The line is intended for both passenger and goods traffic, and will transversely intersect and connect all the existing southern trunk lines from Manchester to London. It will commence from a proposed new centrally-situated terminal station on the southern outskirts of the city, thence running out about seven miles south-westwards direct into Cheshire, and thence through the outer belt of North Cheshire suburban residential districts, at an average radius of nine miles from the Manchester Town Hall, and terminating at a proposed new station at Hazel Grove, adjacent to the Stockport Corporation tramways terminus, and to the Midland Railway Company's new main line station.

MIDDLESEX.—On May 30 Major J. W. Pringle, C.E., representing the Board of Trade, inspected the electric tramway along the Great North Road. He was met by a car at the southern terminus, under Highgate Archway, the boundary between London and Middlesex, and was conveyed through Highgate and Finchley to Whetstone, the northern terminus. Everything was satisfactory, and it is concluded the inspector's report will be favourable and the line speedily opened to the public. The line is part of the County of Middlesex light

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railway scheme, and is leased to the Metropolitan Tramways, Limited. It will be ultimately extended to Barnet in the north. At present the line is about three miles long.

PLYMOUTH.—The Corporation have entered into such serious competition with the Plymouth, Stonehouse, and Devonport Tramways that the company have refused to pay rates, on the plea that the Corporation have resumed possession by running their own cars on the company's lines. The company also have withdrawn payment of certain sums due under their Act, and at a recent meeting of the Council it was resolved that notice in writing be given to the Plymouth, Stonehouse, and Devonport Company, determining forthwith all the rights conferred on the company by section 35 of the said Act, and that all other necessary proceedings be taken to recover payment of the sum due. This resolution was passed, although the town clerk reported that the company intended paying up.

RAMSGATE.—A serious accident occurred on May 26 near the Granville Hotel, Ramsgate, where an accident took place nearly two years ago. A car from the Broadstairs loop line left Thanet Road, and was descending a steep hill, when apparently the brakes failed to act, and the car ran with great speed to the bottom, and then dashed into a grocer's shop. Fortunately the passengers realised their peril and jumped from the car, thus escaping more serious injury. Great excitement and confusion ensued. The grocer's shop was wrecked. A little girl, about seven years of age, the daughter of the manager of the shop, was severely injured. The driver of the car had to be conveyed to a neighbouring surgery in an unconscious condition. The conductor was also removed to the local surgery; and a number of other persons received injuries of a more or less serious character.

SUNDERLAND.—The new electric tramways, commencing where the Sunderland Corporation tramlines end at Grangetown, and extending from that point to Ryhope, Silksworth, and Herrington, are now practically complete. Twelve miles of track have been laid by Messrs. A. Krauss and Son, of Bristol, for the Sunderland District Electric Tramways Company, and the system, which has for 16 months employed 200 men, has involved the expenditure of a quarter of a million of money. There are thirty cars at the Philadelphia sheds ready to be employed on on the system. All are double-deckers. Fifteen of them are not roofed in on the top but are protected by a wind shield of glass and wood. The other fifteen are covered-in double-deckers, and have been built by a French firm, the cost of each car being from £500 to £550. The power-station at Philadelphia is approaching completion.

WALTHAMSTOW.—Col. Von Donop and Mr. Trotter, representing the Board of Trade, inspected the Walthamstow and District Light Railway system on May 26. The lines were formally inaugurated on June 3.

WEDNESBURY.—At a special meeting of the Wednesbury Town Council on May 17, it was decided, subject to the consent of the Board of Trade, to acquire the tramways in the borough, at an estimated cost of about £29,000, from the South Staffordshire Tramways Company. The steam tramways have not been used for about eighteen months, and it is proposed to electrify them.

PATENT LIST.

Specially abstracted for "The Tramway and Railway World" from the Official Journal of Patents.

∴ If the inventions have been communicated the names of the communicators are given below in italics.

APPLICATIONS.

Applications for Letters Patent have been filed as follows:

8,728 Trolley retractor—H. M. Love.
8,822 Regulation of electric circuits subject to rapidly fluctuating loads—E. S. G. Rees, C. H. Iles, and W. Armistead.
8,843 Life-guards for tramcars—W. T. Skelding and Company, Limited, and F. C. Geary.
8,846 Trolley head—R. Baron.
8,847 Apparatus for controlling poles and ropes of electric tramcars—W. J. Bowden and J. W. Cronkshaw.
8,913 Controlling system for electric railways—T. von Zweigbergk.
8,921 Electric railway systems—G. L. Campbell and W. M. Stephens.
8,931 Points for conduit electric tramways—A. N. Connett.
9,107 Method of manufacturing electric traction cells and storage batteries—G. Schauli.
9,134 Charging and discharging secondary batteries for electric train lighting—J. Stone and Company, Limited, and J. R. Quain.
9,162 Trolley collectors—S. Feather, G. R. Feather, H. H. Feather, E. E. Feather, and J. W. Astley.
9,274 Device for preventing accidents through breakage of trolley wires—G. Porritt.
9,294 Moveable waterproof cover for tramcar and other seats—R. Miller.
9,296 Trolley wheel—F. Bamforth.
9,415 Road and rail motor vehicles—J. S. Fairfax.
9,508 Skates or collectors for surface contact tramcars—R. Brown.
9,542 Means for automatically operating points of slot-conduit tramways—W. A. Lawrance.
9,624 Tramcars—F. Bray and G. W. Platt.
9,628 Means for cleaning tram rails—M. B. Mountain and G. M. Gibson.
9,649 Electric railway signalling system—P. R. J. Willis (*J. D. Gordon*).
9,838 Multiple unit controlling apparatus for electric trains—Bruce Peebles and Company, Limited, and J. L. La Cour.
9,993 Safety guard for live rail of electric railways—A. Swanson.
9,999 Means for operating railway and tramway points and signals—W. Taylor.
10,003 Sliding lights of motor 'buses, tramcars, etc.—Metropolitan Amalgamated Railway Carriage and Wagon Company, Limited, and J. S. Currall.
10,100 Overhead current collectors—P. Platte.
10,154 Tram and 'bus ticket holder—A. H. Herra.
10,325 Self-acting ventilator for tramcars, etc.—G. Roberts.
10,446 Trolley poles—J. S. Dronsfield and C. J. J. Huntley.
10,463 Point-openers for tramways—R. Taylor and J. Lambert.
10,503 Car indicator of stopping places, etc.—E. H. Kelley.
10,581 Automatic switch for electric railways—V. Joksch, J. Pettrik, and R. Butta.
10,603 Improvements in tram and railway lines—J. H. Traill.
10,644 Automatic electro-magnetic sanding gear, for use on electric railway and tramway vehicles—M. Cummins.
10,681 Vacuum brake apparatus for railway vehicles—J. W. Cloud.
10,747 Brakes for use on tramway and railway vehicles—M. Cummins.
10,748 Improved method for stopping or abating the nuisance caused by the friction of the wheels of tramcars—W. Webb and W. J. Webb.
10,793 } 10,794 } Electric signalling apparatus—L. B. Woodworth.
10,960 Drill cramps for drilling tramway rails *in situ*—H. Booth.

SPECIFICATIONS ACCEPTED.

The following applications, of which the specifications have been published, are now open to opposition by prior patentees or any other persons interested:

1904.

8,571 Points for tramways and railways—Toogood.
11,077 Railway or tramway signalling systems—British Thomson-Houston Company, Limited (*General Electric Company*).
12,840 Electric train describer—Wells.
21,642 Electrical apparatus for adjusting tram rail points from the car—Macaulay.
27,135 Hangers for trolley wires—Heap, Bailey, Brierley, Billington, Richardson, Haydock, and Jones.
10,698 Dry seats for tramcars—Dent and Leach.
11,052 Points and crossings for railways and tramways—Brown.
11,074 Railway or tramway signalling systems—British Thomson-Houston Company, Limited (*General Electric Company*).
20,039 Apparatus for operating tramway points from the cars—Booth.
13,516 Mechanical ear for trolley wire—Taylor.
13,720 Traction overhead conductor equipment—Schierwater.
9,518 Ears for trolley wires—Richardson, Heap, Heap, Bailey, Brierley, and Billington.
14,021 Dry seat and back cover for tramcars, etc.—Campbell.
14,924 Railway and tramway vehicles—Aston and Brown.
28,486 Tram and vehicle tracks for highways and bridges—Gibbon.

1905.

789 Electric heating of electrically propelled vehicles—Union Elektricitäts Gesellschaft.

LONDON COUNTY COUNCIL TRAMWAY ACCOUNTS.

The report which the Highways Committee presented at a meeting of the London County Council on June 6, contained an abstract of the accounts of the tramways owned by the Council for the year ended March 31 last. The lines on the south side of the Thames, comprising the undertakings purchased from the London, South London, South-Eastern, Metropolitan, London, Deptford, and Greenwich, and London, Camberwell and Dulwich Tramways Companies are first dealt with. The net capital expenditure in respect to the whole of these tramways amounts to £2,623,693, of which £208,364 has been paid out of revenue. During the year the net expenditure on capital account was £499,464.

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This amount includes £102,885 for the purchase of the Deptford and Greenwich tramways and the Camberwell and Dulwich tramways, the remainder being for reconstruction for electric traction of certain sections. The net expenditure in respect of reconstruction at March 31 was £1,470,019. The receipts and working expenses for the year were:

	Electric Traction. £ s. d.	Horse Traction. £ s. d.	Total. £ s. d.
Total receipts	548,296 7 1 ...	133,799 2 0 ...	682,095 9 1
Working expenses...	365,497 12 6 ...	134,328 1 6 ...	499,825 14 0
Making the gross surplus on working	£182,798 14 7 ...	£528 19 6 Deficiency ...	£182,269 15 1

The debt charges amounting to £136,954 have been set against the surplus, and £35,000 has been transferred to renewals reserve fund, leaving a net surplus of £7,054 to be carried to the appropriation account. This compares with a deficiency of £8,284 in the previous year, when no amount was set aside for renewals. The receipts show an increase of £145,856, notwithstanding the fact that Streatham cable tramways were closed during reconstruction for electric traction. The balance of the renewals reserve fund carried forward is £66,607, an increase in the year of £35,835.

The actual working expenses for electric traction were £340,088, or 7·49d. per car-mile run, while the addition of expenditure for temporary generating stations and other special items increased the expenditure to 8·03d. per car-mile. The total expenses for horse traction were 10·23d. per car-mile. The electric working expenses have been considerably higher than they are expected to be when the generating station at Greenwich is completed, and when the use of temporary car-sheds can be dispensed with. The committee regard the year's work, which is considerably more favourable than was expected, as being very satisfactory.

The system extends for a total length of 46⅞ street miles, exclusive of the derelict lines purchased frem the Camberwell and Dulwich Company, and of the total about 26⅜ miles double track have been reconstructed on the conduit system. The following shows the proportions of business done by the electric and the horse lines:

	Electric Traction.	Horse Traction.	Total.
Number of passengers... ...	126,255,280 ..	31,563,280 ...	164,818,560
Number of car miles run ...	10,931,396 ...	3,150,001 ...	14,081,397

These figures, compared with those of 1903, show an increase of 31,679,475 passengers and 2,544,863 car-miles run.

Of the total number of passengers, 35·97 per cent. were carried at ½d. fares, 47·10 per cent. at 1d., 9.12 per cent. at 1½d., 5·01 per cent. at 2d., 1·18 per cent. at 2½d., and 1·62 per cent. at 3d. The average fare per passenger was ·97d., as against ·93d. in 1903-4.

During the year 81 cars have been equipped with roof-covers, while others are being fitted. The covers have been much appreciated by the public, and the earnings of the cars have been considerably increased.

The number of horses at present employed on the horse lines is 1,300, and the average cost per week for provender and litter has been 7s. 6¼d. per horse, as against 8s. 3d. in the previous year.

In reference to the Northern tramways, which are leased to the North Metropolitan Tramways Company, the total capital expenditure at March 31 on these lines, which consist of 48½ street miles, amounted to £871,536. The outstanding debt in respect to the undertaking was £754,491, repayments of capital amounting to £117,045 having been made out of revenue since the acquisition of the undertaking. The Council's receipts from the company amounted to £50,846, which showed a further falling off compared with previous years, owing to the fact that the company had sold its lines outside the county of London. The expenditure for the horse traction debt amounted to £36,103, and the surplus revenue carried to the appropriation account was £22,836.

Capital expenditure amounting on March 31 to £474,715 had been incurred for generating stations, the tramway subway from Southampton Row to Victoria Embankment, street widenings in connection with the tramways, and other matters of a general character. The net amount expended for this purpose during the year was £258,022. Various expenses in connection with the promotion of tramway legislation, with debt charges and preliminary expenses for the reconstruction of the Northern tramways have been charged against this general revenue account, which accordingly showed a debit balance of £18,467 to be carried to the appropriation account against the surplus revenue of the Council's tramways generally. The result, after taking the three accounts into consideration, is that the surplus balance of the appropriation account has been increased from £18,565 on April 1, 1904, to £29,989 on March 31, 1905.

The Committee also submitted particulars of the cost of settling claims in connection with the tramways for the year ending March 31. The amount provided in the estimates for accidents in respect of electric cars was £10,000, while the actual expenditure was £9,726, equal to about ·214d. per car mile, compared with ·246d. in the previous year. As regarded accidents in respect of horse cars, the amount provided in the estimates was £1,250. The actual expenditure was £1,127, working out at about ·086d per car mile, compared with ·103d. in the previous year.

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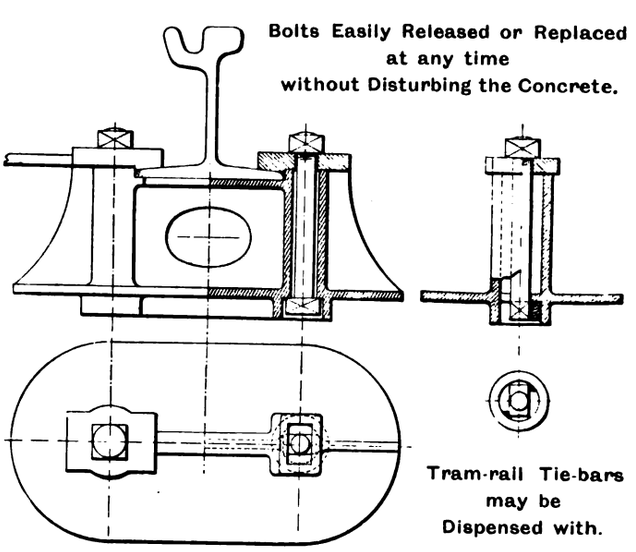

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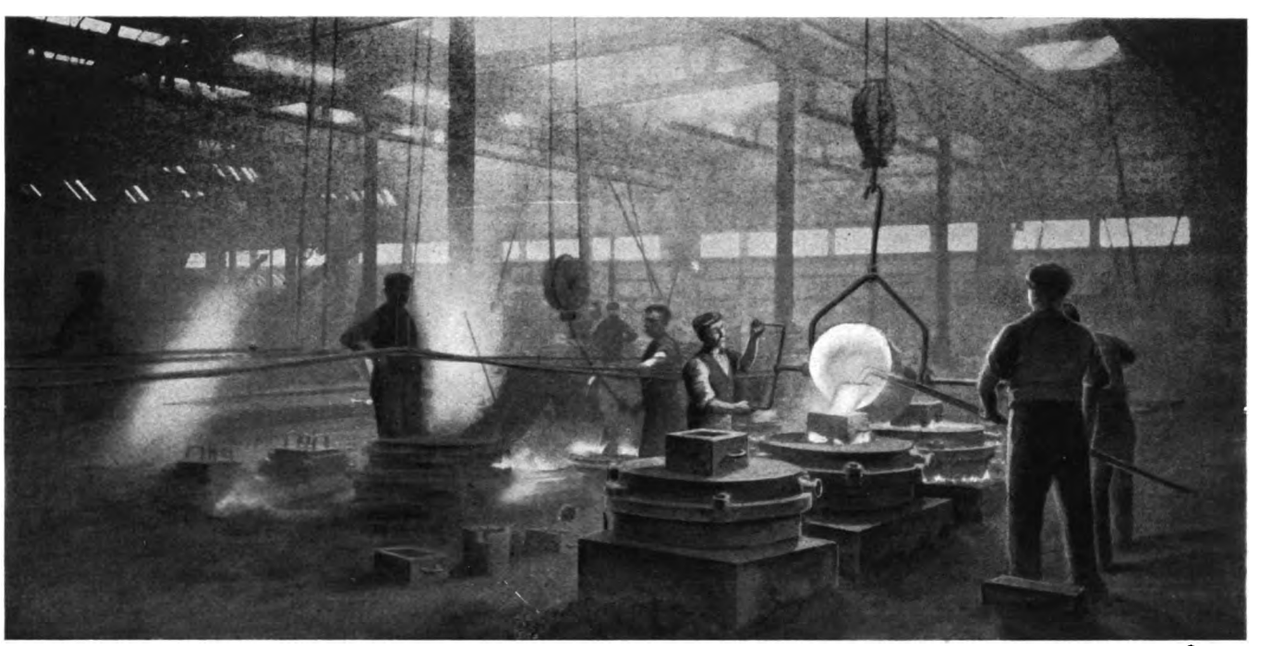

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TRAFFIC RETURNS.

TRAMWAYS AND OMNIBUS LINES.

NAME.	1904. WEEKS ENDING April 30.	May 7.	May 14.	May 21.	1905. WEEKS ENDING April 29.	May 6.	May 13.	May 20.	AGGREGATE. Wks.	1905.	Increase or Dec.
	£	£	£	£	£	£	£	£		£	£
Aberdeen Corporation	1,187	1,219	1,176	1,318	1,178	1,307	1,214	1,258	51	66,834	+ 5,416
Airdrie	186	191	187	198	210	198	195	215	20	3,908	+ 52
Barcelona	1,820	1,902	1,962	1,984	2,221	2,134	2,067	2,174	20	40,307	+ 6,071
Barnsley	168	176	162	170	221	137	160	160	20	3,121	— 15
Barrow	147	153	134	148	300	205	219	234	20	4,055	+ 162
Bath	582	607	580	658	828	627	751	872	20	11,255	+ 973
Belfast City	2,570	2,508	2,442	2,608	2,794	2,188	2,390	2,426	20	45,430	— 1,626
Birmingham, City of	5,228	5,381	5,442	5,578	6,549	5,469	5,881	5,835	20	110,242	+ 6,789
Birmingham Corporation	272	258	257	261	435	342	356	343	7	2,647	+ 679
Birmingham and Midland	838	855	845	861	1,560	1,135	1,249	1,255	20	23,430	+ 6,582
Blackburn Corporation	970	866	788	928	1,518	803	969	992	7	7,314	+ 393
Blackpool and Fleetwood	320	320	299	334	784	341	327	382	20	5,382	+ 124
Blackpool Corporation	507	552	502	512	1,926	564	574	625	7	4,985	+ 445
Blackpool, St. Anne's, and Lytham	248	252	286	256	765	226	280	321	28	5,100	- 93
Bolton Corporation	1,787	1,698	1,788	1,753	1,841	1,916	1,902	1,902	8	14,268	+ 650
Bournemouth Corporation	1,018	973	977	988	1,577	1,176	1,075	1,044	6½	7,538	116
Bradford Corporation	4,000	5,566	4,055	4,357	5,530	4,024	4,260	4,206	8	30,794	— 457
Brighton Corporation	814	786	866	911	1,092	944	937	938	7	6,862	+ 462
Bristol	4,796	4,942	4,788	5,105	5,714	4,675	4,992	4,872	20	92,413	— 479
Burnley Corporation	997	984	975	1,011	1,027	1,053	1,118	1,102	20	20,760	+ 2,418
Burton on-Trent Corporation	313	307	322	337	356	305	310	307	7	2,305	— 140
Calcutta	Rs. 31,038	35,439	32,833	33,130	34,988	38,508	36,684	38,079	19	752,767	+ 86,433
Cardiff Corporation	1,880	1,9.0	1,872	1,997	2,288	1,905	1,923	1,948	7	14,364	+ 25
Carlisle, City of	178	189	175	206	229	210	181	188	20	3,222	— 328
Chatham and District	559	607	537	601	801	624	657	543	20	11,964	+ 1,306
Colchester Corporation	...	...	...	...	188	184	176	172	43	9,167	—
Cork	484	484	452	483	509	463	505	573	20	8,626	+ 427
Darlington Corporation	...	...	...	...	...	193	205	188	7	1,378	—
Derby Corporation	326	318	329	346	801	613	685	676	7	4,919	+ 2,441
Devonport	482	516	482	580	519	437	471	466	20	8,858	- 542
Dover Corporation	182	188	194	201	256	195	198	179	7	1,446	— 174
Dublin and Lucan	103	110	120	121	159	100	117	129	20	2,081	+ 51
Dublin United	5,205	4,986	4,791	4,984	5,661	4,807	5,001	5,689	20	91,834	+ 1,832
Dudley—Stourbridge	825	814	770	836	1,302	781	878	884	20	15,997	+ 780
Dundee City	795	861	790	880	836	844	823	879	48	43,367	+ 335
East Ham U.D.C.	728	739	638	771	929	768	866	830	7	5,748	+ 252
Edinburgh and District	4,149	4,313	4,161	4,656	4,760	4,823	4,946	5,029	20	90,694	+ 7,531
Gateshead	853	907	836	867	1,006	853	870	884	20	17,491	+ 455
Glasgow Corporation	13,916	14,242	14,112	14,855	15,889	15,116	15,321	16,152	51	782,994	+ 40,239
Glossop U.D. Council	99	111	103	...	128	128	129	...	...	...	—
Gloucester Corporation	...	...	...	...	...	...	297	286	7½	2,287	—
Gravesend and Northfleet	235	243	227	257	303	205	224	216	20	4,009	- 439
Greenock—Port Glasgow	538	542	585	547	716	598	655	720	20	11,290	+ 1,679
Halifax Corporation	(2 weeks)	2,849	(2 weeks)	2,624	(2 weeks)	3,392	(2 weeks)	3,042	6	10,226	+ 627
Harrow Road and Paddington	277	291	257	301	302	239	283	270	20	4,754	257
Hartlepool	266	282	259	294	315	234	246	241	20	4,867	158
Huddersfield Corporation	1,208	1,183	1,189	1,267	1,746	1,159	1,252	1,348	7	8,558	+ 470
Hull Corporation	2,034	2,037	1,993	2,095	2,255	2,048	2,037	2,019	7	15,203	+ 13
Ilford Corporation	446	...	432	489	546	...	492	472	7	3,292	+ 157
Ilkeston Corporation	141	126	138	207	106	126	124	114	...	...	-
Ipswich Corporation	397	402	401	462	479	376	405	394	7	2,900	300
Isle of Thanet	...	403	432	511	...	415	478	433	20	6,451	+ 73
Kidderminster	111	115	106	119	164	93	118	112	20	1,956	— 86
Kirkcaldy Corporation	202	208	211	216	272	211	218	224	...	...	—
Lanarkshire	623	630	615	645	852	640	687	748	20	13,005	+ 1,134
Leeds Corporation	5,391	5,481	5,250	5,579	6,964	5,461	5,783	5,678	8	45,639	+ 1,921
Leicester Corporation	...	...	...	...	2,437	1,919	2,173	2,110	20	38,020	—
Liverpool Corporation	10,072	10,067	9,966	11,451	10,892	10,474	10,518	13,796	8	14,354	+ 21,724
London County Council	10,644	10,728	10,588	10,854	14,262	13,249	14,252	10,688	20	302,692	+ 8,414
London General Omnibus	24,770	25,835	25,115	26,231	28,978	24,626	26,550	25,444	19	425,747	+ 5,239
London Road Car	8,205	8,399	8,336	8,710	7,891	8,244	8,918	8,568	20	151,240	+ 2,163
Lowestoft Corporation	145	136	145	164	173	135	147	135	...	...	—
Maidstone Corporation	...	...	...	...	148	110	125	125	41	5,569	—
Manchester Corporation	11,918	11,602	11,355	11,991	12,938	11,947	12,380	12,672	7	80,144	- 4,640
Merthyr	178	209	188	201	281	205	177	191	20	3,720	- 144
Metropolitan	1,304	1,350	1,262	1,454	2,768	2,111	2,573	2,358	20	13,691	- 7,803
Middleton	308	308	285	343	494	284	356	376	20	5,863	- 516
Nelson Corporation	114	108	104	108	125	125	123	131	8	948	+ 101
Newcastle-upon-Tyne Corporation	3,794	3,646	3,534	3,640	3,986	3,575	3,575	3,572	20	71,649	+ 1,208
Newport (Mon.) Corporation	...	472	475	481	...	553	552	598	7	4,048	+ 687
Northampton Corporation	115	138	109	143	570	384	417	392	7	2,899	+ 1,892
North Metropolitan	11,920	12,108	11,969	12,708	12,421	11,740	12,769	12,293	20	222,265	- 1,840
Oldham—Ashton	556	562	501	550	703	489	542	567	20	10,260	+ 169
Oldham Corporation	1,130	1,089	1,106	1,152	1,707	1,566	1,558	1,537	8	13,087	+ 3,404
Peterborough	137	150	161	160	211	119	143	124	20	2,186	— 128
Pontypridd U.D. Council	...	...	...	...	264	150	146	160	7	1,258	—
Poole	288	292	285	287	434	289	296	295	20	4,959	159
Portsmouth Corporation	1,656	1,703	1,715	1,731	2,356	1,769	1,894	1,771	7	13,138	288
Potteries	1,831	1,675	1,622	1,665	1,839	1,604	1,625	1,653	20	32,830	+ 388
Rossendale Valley	186	185	189	175	226	190	193	208	20	3,735	+ 362
Rotherham Corporation	436	440	406	459	577	366	426	418	7	2,942	- 267
Rothesay	83	98	71	89	238	108	85	111	20	1,383	+ 107
Salford Corporation	3,967	3,685	3,947	4,082	4,003	4,120	4,167	4,115	8	30,984	+ 940
Scarborough Corporation	...	...	...	...	131	88	95	87	20	1,517	-
Sheerness	49	53	46	57	87	62	68	65	20	1,176	+ 233
Sheffield Corporation	4,886	4,279	4,573	4,629	5,141	4,689	4,866	4,677	8	38,243	+ 671
Southampton Corporation	911	910	908	956	1,011	877	917	914	7	6,298	307
Southend-on-Sea Corporation	264	252	306	440	458	317	318	313	8	2,430	+ 70
Southport	294	335	293	314	453	314	292	317	20	5,133	158
South Staffordshire	724	738	684	780	981	628	706	709	20	13,398	— 660
Stockport Corporation	505	528	...	661	686	472	590	687	7	4,088	+ 282
Sunderland Corporation	1,135	1,121	1,185	1,260	1,368	...	1,177	1,157	7	8,604	— 156
Swansea	479	494	485	592	958	753	780	809	20	10,728	+ 1,275
Swindon Corporation	...	...	...	...	176	...	...	...	...	...	—
Taunton	47	61	50	49	65	55	46	49	20	879	— 97
Tynemouth	242	268	220	261	321	202	244	227	20	3,780	— 622
Tyneside Tramways and Tramroads	338	337	313	364	719	332	383	394	20	7,142	+ 1,146
Wallasey U.D. Council	655	669	649	682	846	736	737	748	7	5,257	+ 359
Walsall Corporation	512	454	438	485	566	437	465	469	19	9,067	194
Warrington Corporation	308	297	281	308	371	317	311	332	7	2,272	+ 146
West Ham Corporation	716	742	970	789	1,886	1,449	1,658	1,594	7	9,996	+ 4,527
Weston-super-Mare	68	63	76	79	162	96	96	110	20	992	+ 158
Wolverhampton Corporation	578	542	542	467	697	749	754	719	8	5,830	—
Wolverhampton District	359	399	355	389	549	324	378	367	20	7,084	+ 143
Worcester	262	308	287	314	381	283	308	298	20	5,401	+ 877
Wrexham and District	105	102	130	105	127	91	93	100	20	1,952	— 160
Yorkshire (Woollen) District	601	754	542	620	923	548	649	641	20	11,790	+ 970

(For Railway Companies' Traffic Returns, *ride* page 112.)

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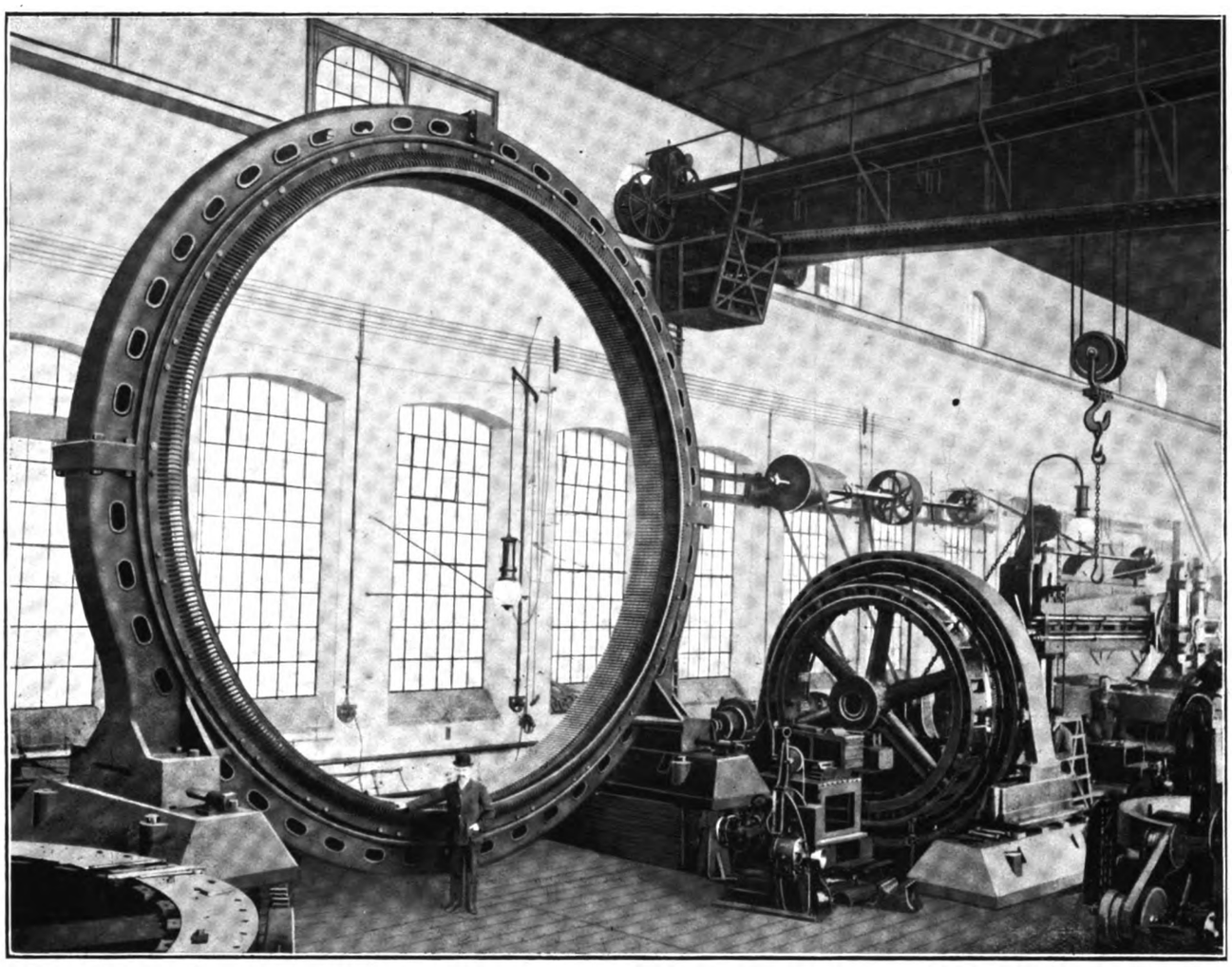
ELECTRIC CONSTRUCTION CO., LTD.

Electrical Engineers and Contractors.



ARMATURE RING OF ONE OF **FOUR 3200 K.V.A.** THREE-PHASE ALTERNATORS UNDER CONSTRUCTION FOR THE LONDON COUNTY COUNCIL.

LONDON & WOLVERHAMPTON

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RAILWAY TRAFFIC RETURNS.

RAILWAY COMPANIES.	1904. WEEKS ENDING April 30.	May 7.	May 14.	May 21.	1905. WEEKS ENDING April 29.	May 6.	May 13.	May 20.	AGGREGATE. Wks.	1905	Increase or Dec.
	£	£	£	£	£	£	£	£		£	£
Brecon and Merthyr	1,755	2,027	1,918	2,054	1,799	1,975	1,978	2,004	20	33,254	+ 1,132
Cambrian	6,558	7,046	6,517	6,976	7,083	6,176	6,022	5,206	20	107,294	− 5,155
Central London	6,850	6,950	6,708	6,549	6,674	6,896	6,759	6,715	20	140,386	+ 1,990
City and South London	2,681	2,846	2,832	2,656	2,808	2,754	2,555	2,486	21	60,229	− 3,146
Furness	8,999	9,642	8,605	9,143	9,172	9,315	9,345	9,254	20	172,077	+ 3,583
Great Central	61,799	62,018	62,294	69,822	60,585	67,372	67,278	66,810	20	1,304,376	+ 65,325
Great Eastern	98,000	99,000	93,700	112,100	98,900	96,300	92,400	95,000	20	1,862,300	− 54,300
Great Northern	110,169	106,759	106,343	119,780	103,300	107,300	108,500	108,200	20	2,070,300	− 72,647
Great Northern and City	917	923	927	977	1,586	1,558	1,503	1,509	20	31,655	--
Great Western	229,200	234,800	229,000	267,400	232,900	238,300	237,200	229,300	20	4,310,500	− 32,000
Hull and Barnsley	9,533	9,209	9,778	10,266	7,636	8,690	10,176	8,890	20	172,874	+ 4,215
Isle of Wight	663	639	670	741	872	640	669	676	20	11,584	+ 173
Ditto Central	796	614	675	622	841	754	679	640	20	12,652	+ 639
Lancashire and Yorkshire	98,648	99,074	97,208	116,378	102,523	108,749	101,234	103,518	20	1,981,773	+ 35,423
Liverpool Overhead	1,553	1,594	1,656	1,643	1,684	1,575	1,551	1,522	20	31,424	− 1,382
London, Brighton, and South Coast	61,380	56,860	53,997	63,369	66,847	61,785	54,733	54,743	20	1,101,379	− 13,860
London and North-Western ...	279,000	263,000	267,000	303,000	259,000	266,000	271,000	263,000	20	5,106,000	− 99,000
London and South-Western ...	89,600	83,400	87,000	98,800	105,000	85,100	91,800	87,400	20	1,646,800	+ 20,600
London, Tilbury, and Southend ...	8,618	7,704	7,874	9,600	9,995	7,858	8,065	8,106	20	156,781	+ 991
Maryport and Carlisle	2,184	2,023	2,046	2,152	2,176	2,027	2,021	2,081	20	41,391	+ 1,205
Mersey	1,614	1,626	1,448	1,518	1,773	1,650	1,652	1,555	20	32,078	+ 1,893
Metropolitan	17,633	17,763	17,696	18,598	17,973	17,832	17,615	17,751	20	344,811	+ 816
Ditto District	7,295	7,419	7,520	7,360	7,003	7,298	7,273	7,238	20	149,010	− 4,218
Midland	217,207	207,578	208,893	245,773	204,629	218,939	213,616	211,004	20	4,212,566	− 25,979
North-Eastern	170,567	175,274	169,651	194,269	169,862	160,616	170,040	171,039	20	3,264,838	− 52,350
North London	9,458	9,084	9,253	8,832	9,020	8,627	8,758	8,777	20	179,804	− 12,163
North Staffordshire...	17,422	18,275	16,596	18,769	17,400	16,784	17,075	17,080	20	338,717	10,705
South-Eastern and Chatham ...	86,073	92,491	80,846	94,658	90,738	98,888	85,916	82,952	20	1,622,923	− 13,689
Taff Vale and Penarth	19,204	18,838	19,576	18,893	16,419	18,653	18,696	17,173	20	364,591	− 8,873
Caledonian	84,719	79,147	80,653	83,159	90,910	80,220	81,706	83,352	16	1,296,611	+ 12,405
Glasgow and South-Western ...	34,014	31,108	31,367	33,700	35,294	31,242	31,189	31,923	16	498,292	− 6,908
Glasgow District Subway	1,356	1,367	1,353	1,270	1,293	1,285	1,250	1,208	16	21,136	− 498
Great North of Scotland	9,703	9,917	9,459	9,342	9,328	9,349	9,076	9,088	16	136,078	− 4,646
Highland	8,699	8,945	8,877	8,847	8,281	8,678	8,405	8,530	16	133,513	− 5,234
North British	89,215	87,842	86,046	90,360	93,095	86,891	85,073	86,830	16	1,355,829	+ 265
Belfast and County Down	2,497	2,677	2,588	2,796	3,615	2,847	2,947	3,208	20	50,066	+ 934
Cork and Bandon	1,810	1,839	1,826	1,695	1,796	1,848	1,785	1,775	20	32,138	− 504
Dublin, Wicklow, and Wexford ...	7,081	6,209	5,021	5,055	6,691	5,516	5,315	5,376	20	97,573	+ 1,844
Great Northern of Ireland	18,833	17,530	17,521	17,865	20,479	18,172	18,413	17,910	20	336,212	− 2,316
Great Southern and Western ...	28,849	28,923	25,789	25,039	28,316	27,969	25,711	25,133	20	465,810	− 12,062
Midland Great Western	13,101	11,478	11,272	11,077	13,522	12,387	10,456	10,141	20	207,779	− 6,263

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TO
The British Dairy Farmers' Association.

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Vol. XVII., No. 23.

Contents, Page xi. Index to Advertisements, Page xiii.
Directory of Electric Tramways Page xxxvi.

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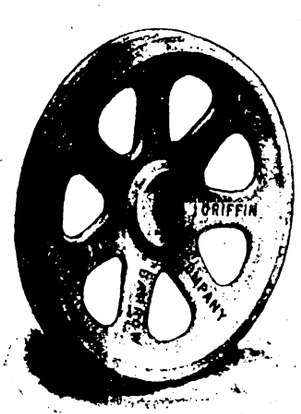
ILLUSTRATED

A REVIEW OF PROGRESS IN *Electric* AND OTHER *Traction.*



BRITISH GRIFFIN CAR WHEELS

Works:
BARROW-IN-FURNESS.

STAND No. 78 at the Electric Tramway & Railway EXHIBITION, JULY 3rd-14th, 1905.

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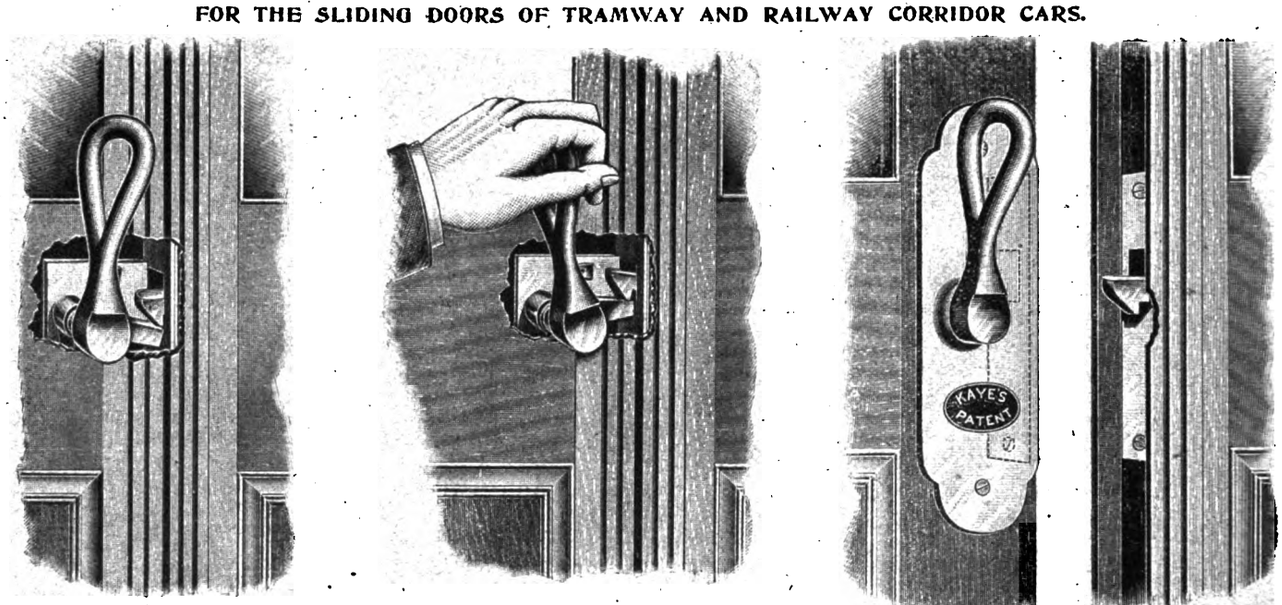
KAYE'S NEW PATENT AUTOMATIC DOOR FASTENER

FOR THE SLIDING DOORS OF TRAMWAY AND RAILWAY CORRIDOR CARS.



DOOR FAST. DOOR BEING RELEASED. DOOR RELEASED.

The above illustrations show the simplicity of this fastener. Hitherto the hook in the jamb or standing pillar has been made rigid, causing a great power to be put upon the handle to shut the door. With the above the latch yields and secures the door quite easily, while the act of sliding the door open with the handle raises the hook and automatically releases the door.

These Latches are now being largely used by the leading English Railways for Corridor Trains and Tram Cars.

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SAVES Wear & Tear of Plant.

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Electric Tramway & Railway Exhibition,

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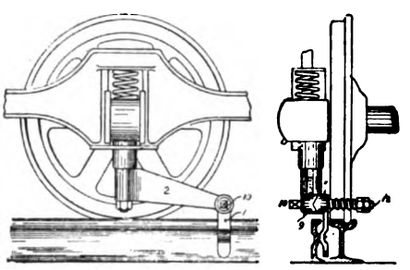
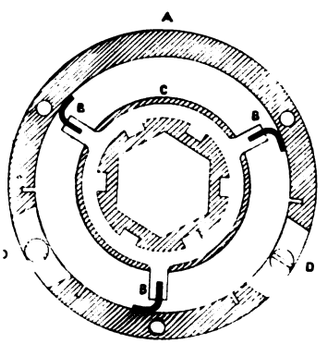


VIEW OF STRIKER IN SLOT.



SECTIONAL VIEW OF SWITCH SHOWING BRUSHES.

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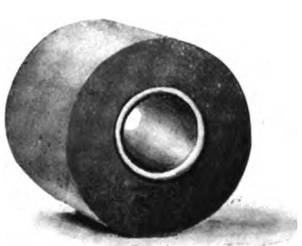

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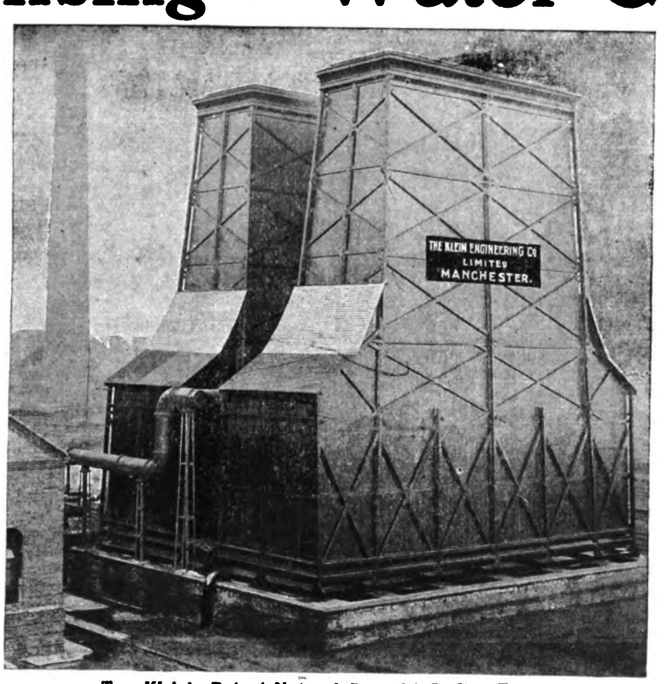

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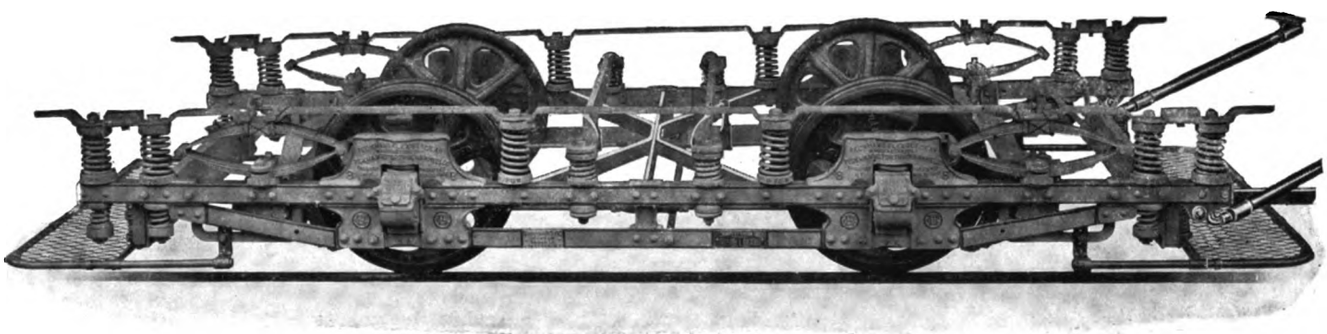

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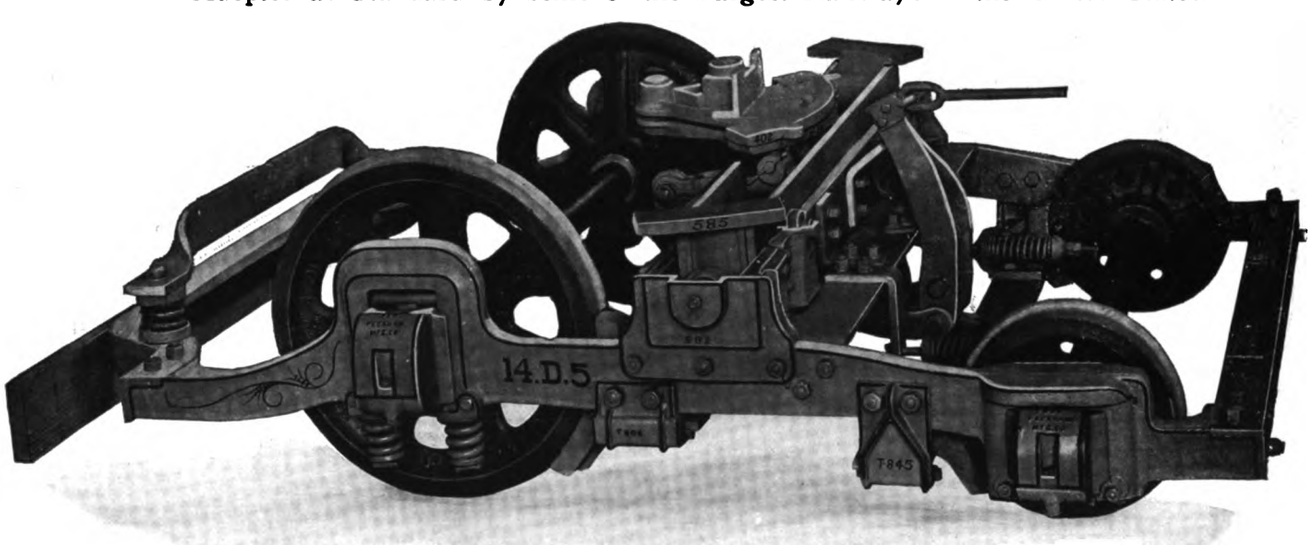

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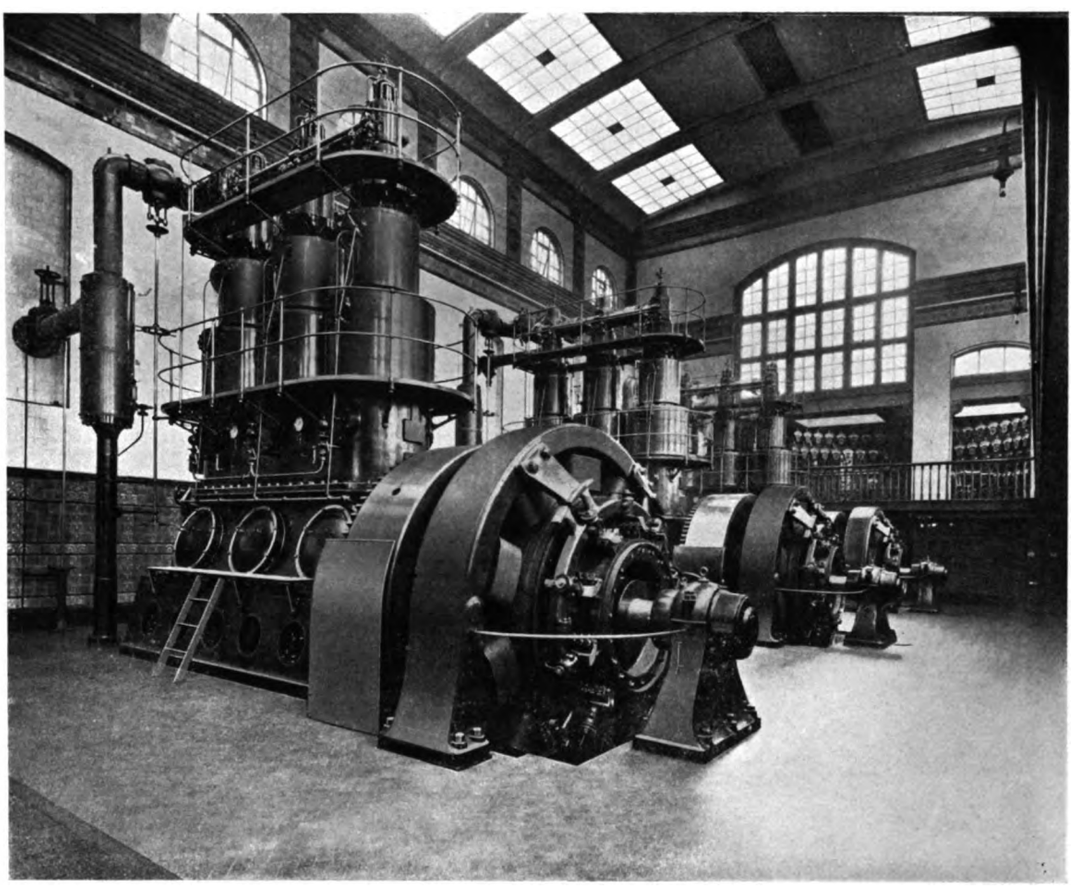

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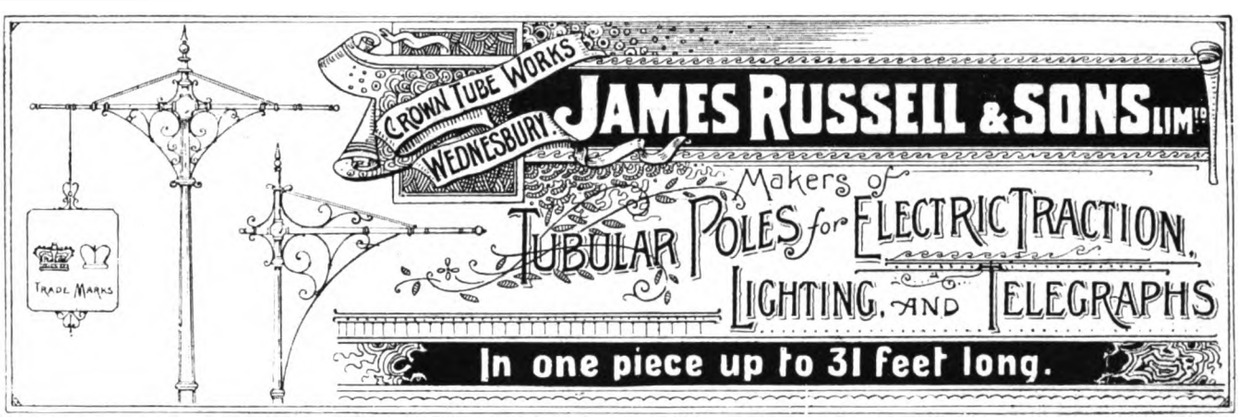

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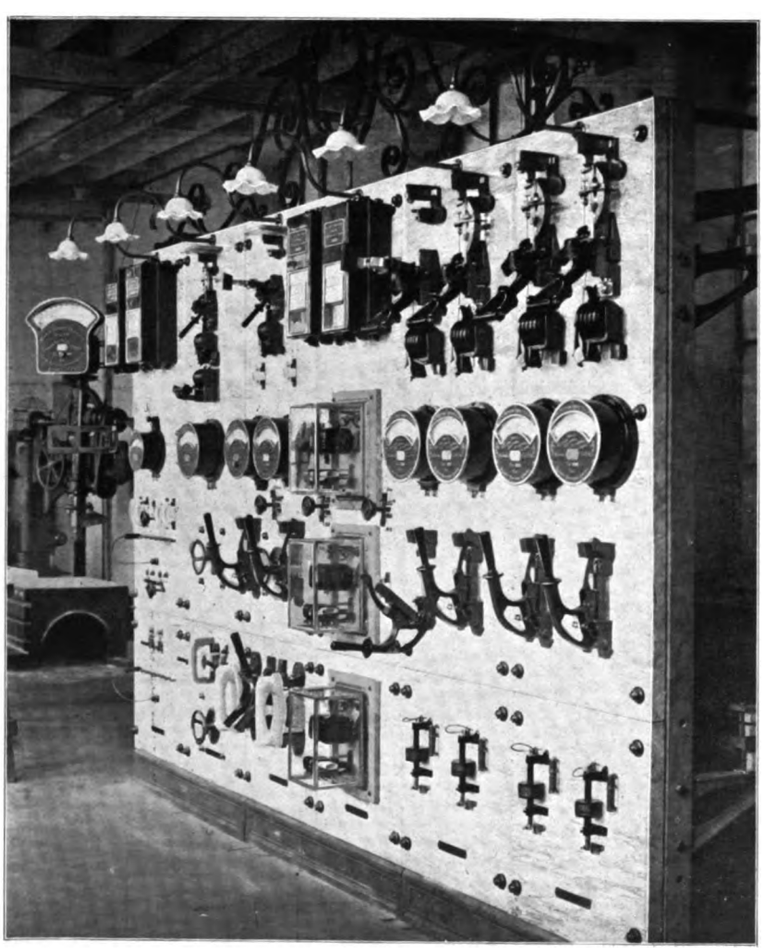

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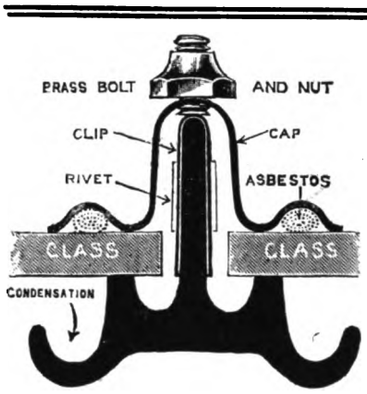

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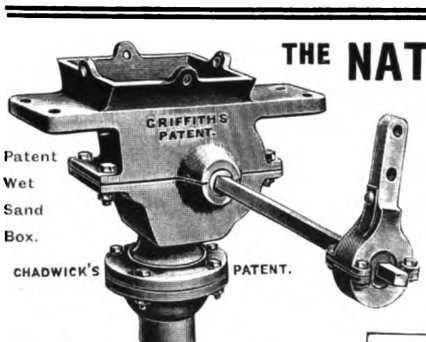

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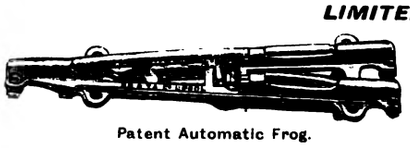

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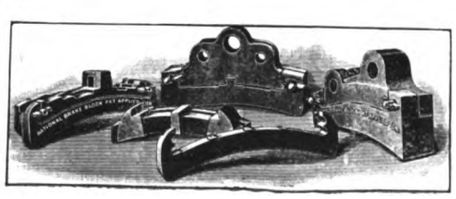

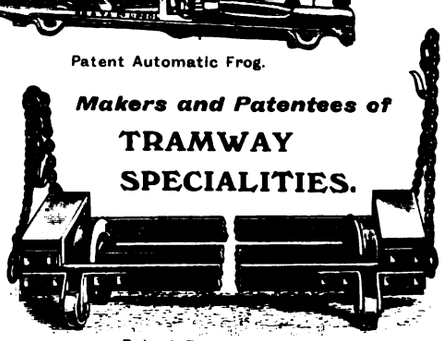

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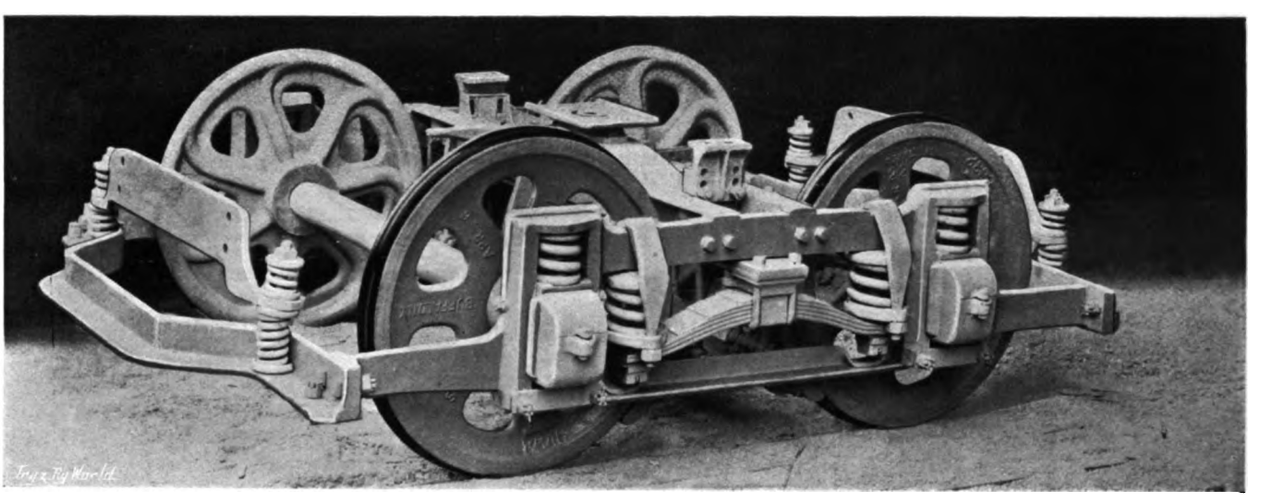

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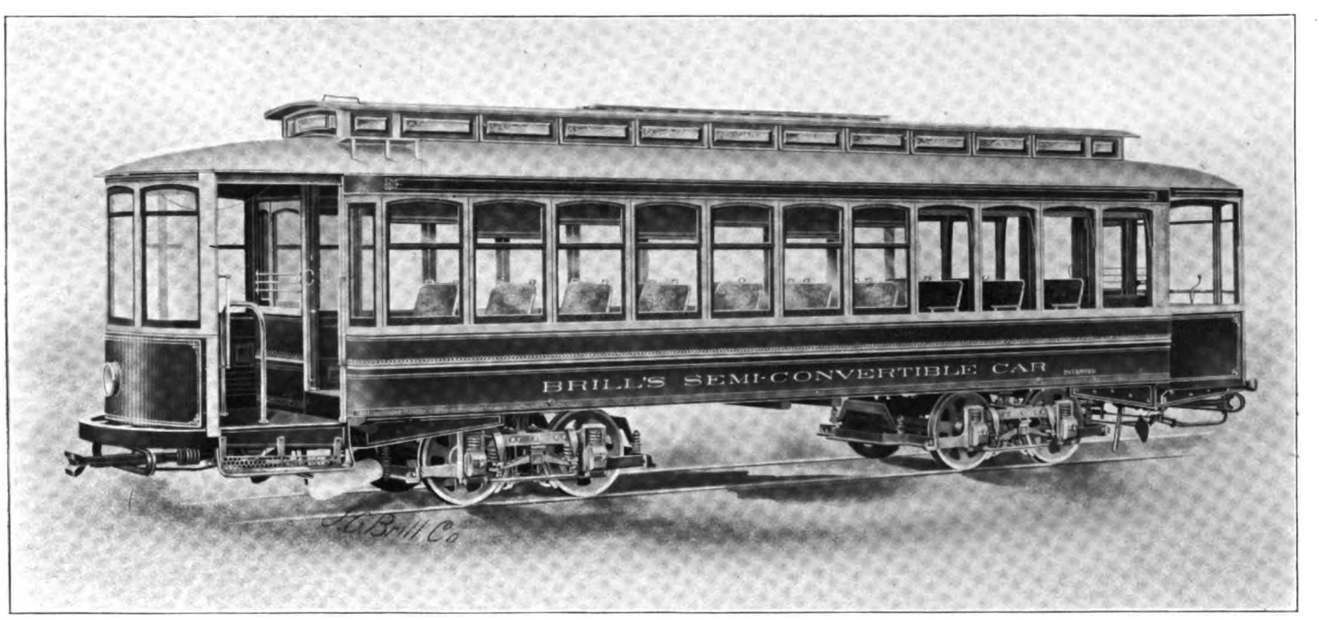

BRILL SEMI-CONVERTIBLE CAR (PATENTED).

in the pocket; and, moreover, the sashes may be held at any desired height by five window lock stops. Dropping the sashes into a wall window-pocket means two or more operations; the hands must be changed from bottom to top of sash, and if not careful, hands will get pinched. Most passengers let the sash slam down into the pocket, which is safer for their hands than for the sash. To say that the propensity of a certain class of passengers to use the wall window pockets as a rubbish collector and substitute for a cuspidor is a nuisance, is to put it mildly—it is a serious menace to the health of all who ride in the cars. The side roof is the logical place for the window pocket—there is no reason why it should not be put there, and every reason why it should. Another thing, the low window sill obtained by not having wall pockets is a decided advantage, and one that is everywhere appreciated. It makes the car more open, and brighter and more attractive in winter. The standard height of the top of window sill from the floor in the Brill Semi-Convertible is $24\frac{3}{8}$ inches. The car is patented in Great Britain, France, Italy, Belgium, Hungary, Argentine Republic, and the United States.

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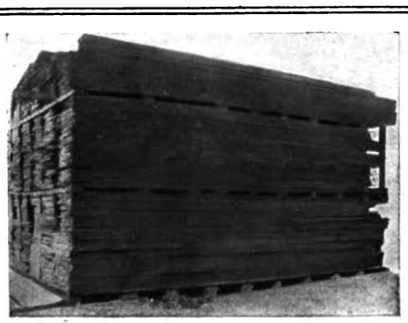
(Continued on page xx.)



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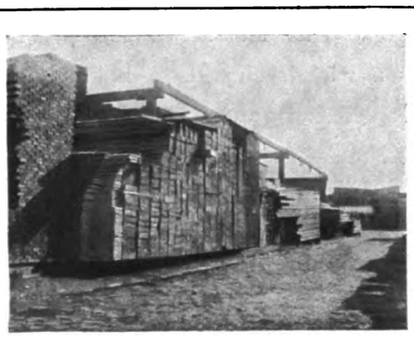

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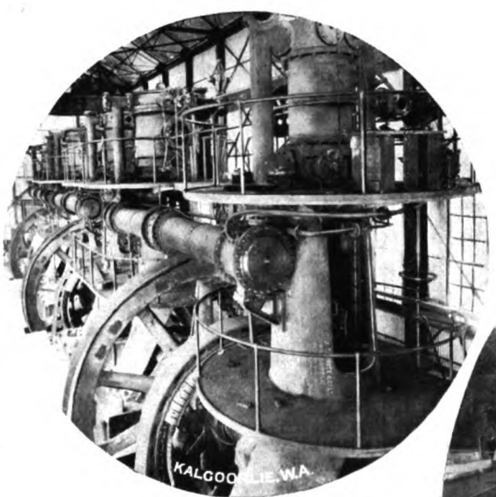

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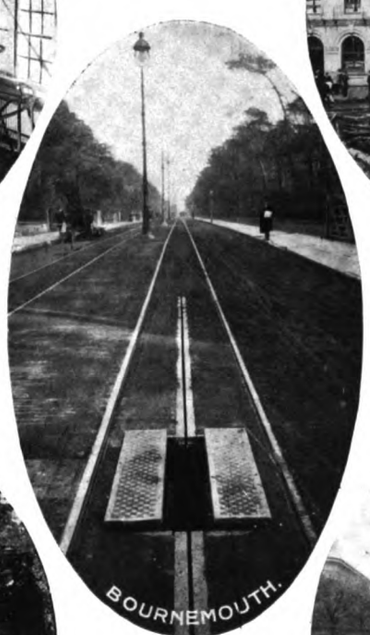

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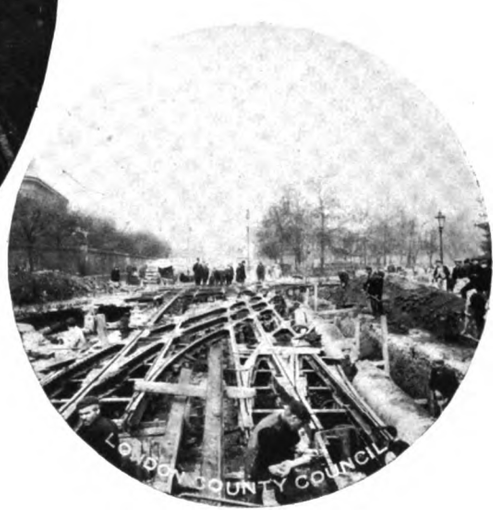

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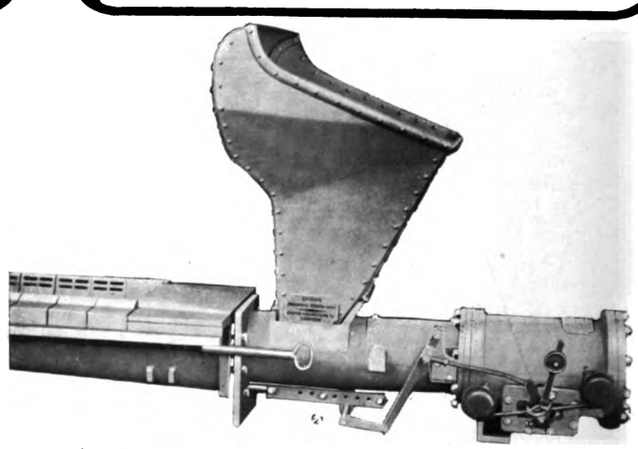

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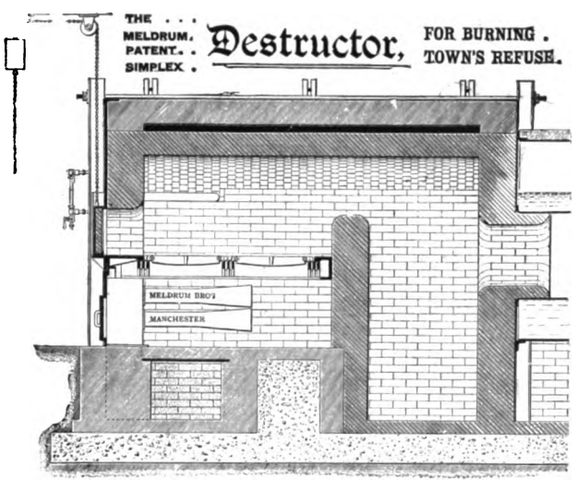

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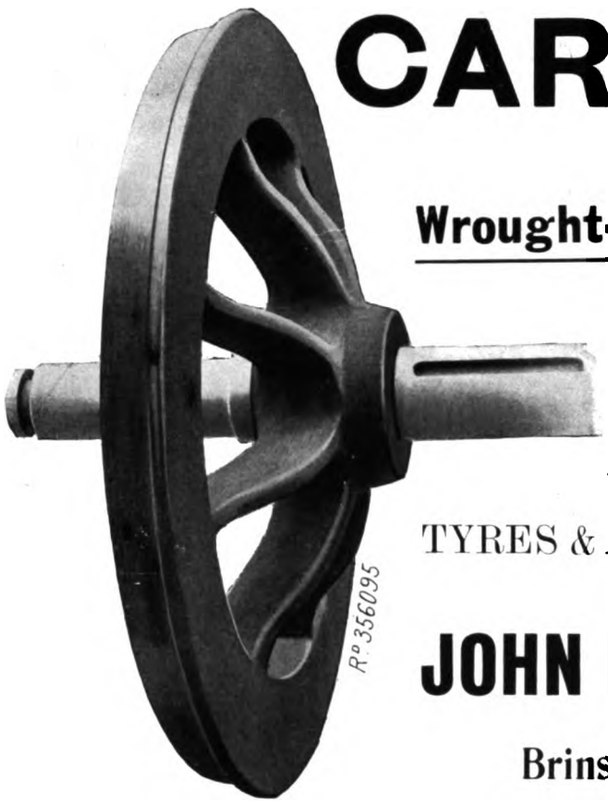

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Hadfield's Steel Foundry Co., Sheffield.
Leeds Steel Works, Ltd., Leeds.
Lorain Steel Company, London.
North Eastern Steel Co., Ltd., Middlesbro'.
Penney & Co., London, E.C.

RAILWAY CARRIAGES.
Blackwell, R. W., & Co., Ltd., London, E.C.
Brill Company, J. G., London, S.W.
Brush Elec. Engineering Co., Ltd., London.

RAILWAY AND TRAMWAY MOTORS, ELECTRIC.
Brill Company, J. G., London, S.W.
British Thomson-Houston Co., Ltd., London.

RAILWAY & TRAMWAY MOTORS, ELECTRIC—*cont.*
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Bruce Peebles & Co., Ltd., Edinburgh.
Brush Elec. Engineering Co., Ltd., London
Dick, Kerr, & Co., Ltd., London.
Electric Construction Co., Ltd., London.
Greenwood & Batley, Ltd., Leeds.
Johnson & Phillips, Charlton, S.E.

ROOFS.
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Andrew Handyside & Co., Ltd., Derby.

SAND BOXES.
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SNOW PLOWS.
Brill Company, J. G., London, S.W.

SPRINGS.
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Brill Company, J. G., London, S.W.
Brown Bayley's Steel Works, Ltd., Sheffield.
Tempered Spring Co., Ltd., Sheffield.
Edgar Allen & Co., Ltd., Sheffield.
Hadfield's Steel Foundry Co., Sheffield.

SPRINKLING CARS.
Brill Company, J. G., London, S.W.

STEAM ENGINES. (See Engines.)

STEAM VALVES.
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Dixon, S., & Son, Ltd., Leeds.
Noakes and Sons, Thos., London, E.

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Tempered Spring Co., Ltd., Sheffield.

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Edgar Allen & Co., Ltd., Sheffield.
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Edgar Allen & Co., Ltd., Sheffield.

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Edgar Allen & Co., Ltd., Sheffield.
Hadfield's Steel Foundry Co., Sheffield.
Penney & Co., London, E.C.

TICKET PUNCHES. (See Punches).

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Bell Punch & Printing Co., Ltd., London.
Glasgow Numerical Printing Co., Glasgow.
Ticket Punch & Register Co., Ltd., London.
Whiting and Sons, T. J., Ltd., London, E.C.
Williamson, Alfred, Ashton-under-Lyne.

TIMBER.
Owen & Sons, Ltd., Jos., Liverpool.

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Brush Elec. Engineering Co., Ltd., London.
Elec. Try. & Rly. Carge. Works, Ltd., Preston.
Milnes, Voss & Co., Birkenhead.

TOWER WAGONS.
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TRACK BROOMS
Brill Company, J. G., London, S.W.

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Youngs, Ryland St. Works, Birmingham.

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TRAMWAY LOCOMOTIVES.
Brill Company, J. G., London, S.W.
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Dick, Kerr, & Co., Ltd., London.

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Brill Company, J. G., London, S.W.
Dick, Kerr, & Co., Ltd., London.
Edgar Allen & Co., Ltd., Sheffield.
Electric Tram. Equipment Co., Birmingham.
Hadfield's Steel Foundry Co., Sheffield.

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Milnes, Voss & Co., Birkenhead.
Owen & Sons, Ltd., Jos., Liverpool.
Tidswell's Car Guard Co., Bradford.

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Blackwell, R. W., & Co., Ltd., London, E.C.
British Thomson-Houston Co., Ltd., London.
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Brush Elec. Engineering Co., Ltd., London.
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Fleming, Birkby, & Goodall, Liversedge.

TROLLEY WHEELS AND HEADS.
Bergtheil & Young, London, E.C.
Blackwell, R. W., & Co., Ltd., London, E.C.
Dixon, S., & Son, Ltd., Leeds.
Electric Try. Equipment Co., Birmingham.
Fleming, Birkby, & Goodall, Liversedge.

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Blackwell, R. W., & Co., Ltd., London, E.C.
Frederick Smith & Co., Salford, Manchester.
Roeblings' Sons Co., New York.

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Blackwell, R. W., & Co., Ltd., London, E.C.
Brill Company, J. G., London, S.W.
Brush Elec. Engineering Co., Ltd., London.
Dick, Kerr, & Co., Ltd., London.
Greenwood & Batley, Ltd., Leeds.
Lorain Steel Company, London.
Milnes, Voss & Co., Birkenhead.

TUBES, COPPER AND BRASS.
Russell, James, & Son, Ltd., Wednesbury.

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Baker, John & Co. (Rotherham, Ltd.).
Edgar Allen & Co., Ltd., Sheffield.
Hadfield's Steel Foundry Co., Sheffield.
Winby, L.P., & Co., London, E.C.

UNIFORMS.
Pearse, J. & B., London.
Pearson, Huggins & Co., London.

VARNISHES.
Blackwell, R. W., & Co., Ltd., London, E.C.
Docker Bros., Ltd., London.
Standard Varnish Works, London, E.C.
Tabor, Trego, and Co., London, E.

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British Westinghouse Co., Ltd., London.
Electric Construction Co., Ltd., London.
Johnson & Phillips, Charlton, S.E.
Kelvin & White, Glasgow.
Nalder Bros. & Thompson, Ltd., London E.C.

WAGONS.
Milnes, Voss & Co., Birkenhead.

WELDED JOINTS.
Thermit, Limited, London, E.C.

WHEEL PRESSES.
Youngs, Ryland St. Works, Birmingham.

WHEELS AND AXLES.
Baker, John, & Co., Ltd., Rotherham.
Brill Company, J. G., London, S.W.
British Griffin Co., Ltd., London.
Brush Elec. Engineering Co., Ltd., London.
Edgar Allen & Co., Ltd., Sheffield.
Glasgow Railway Engineering Co., Glasgow.
Greenwood & Batley, Ltd., Leeds.
Hadfield's Steel Foundry Co., Sheffield.
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Miller & Co., Ltd., Edinburgh.

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Glasgow Railway Engineering Co., Glasgow.

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Frederick Smith & Co., Salford, Manchester.
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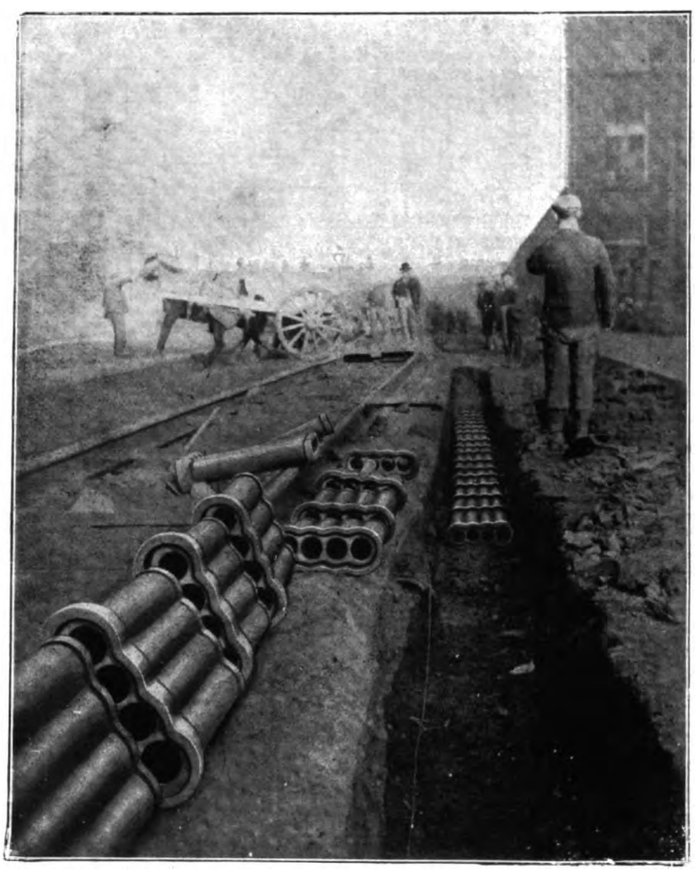
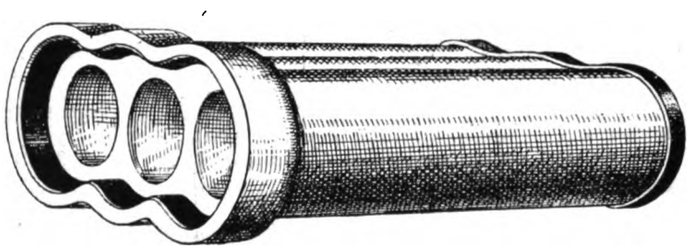


LAYING SYKES' CONDUITS AT STALYBRIDGE.



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READING
REDHILL
REIGATE
ROCHDALE
ROTHERHAM
ROWLEY REGIS
SANDRINGHAM
SALFORD
SHEFFIELD
SOUTHAMPTON
SOUTHEND
SOUTH SHIELDS
ST. JAMES' and PALL MALL
STEPNEY
SUNDERLAND
STALYBRIDGE
SHOREDITCH
SWANSEA
THORNHILL
TWICKENHAM—LONDON UNITED TRAMWAYS
UXBRIDGE
WAKEFIELD
WALKER and WALLSEND
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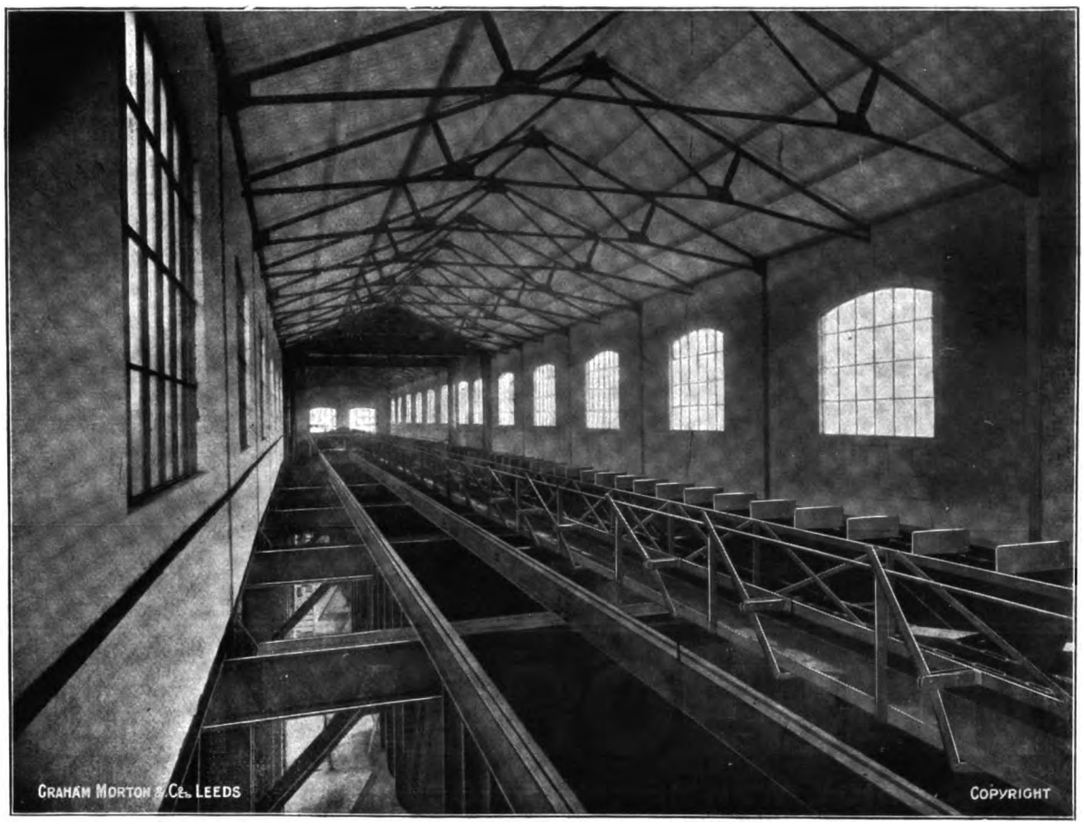

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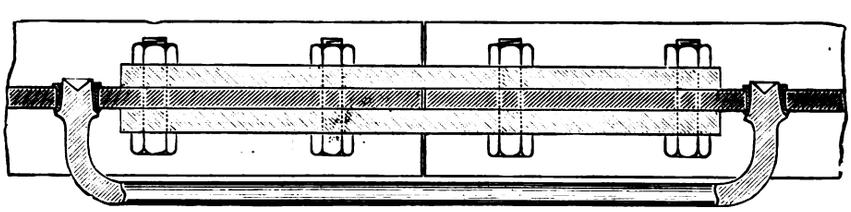

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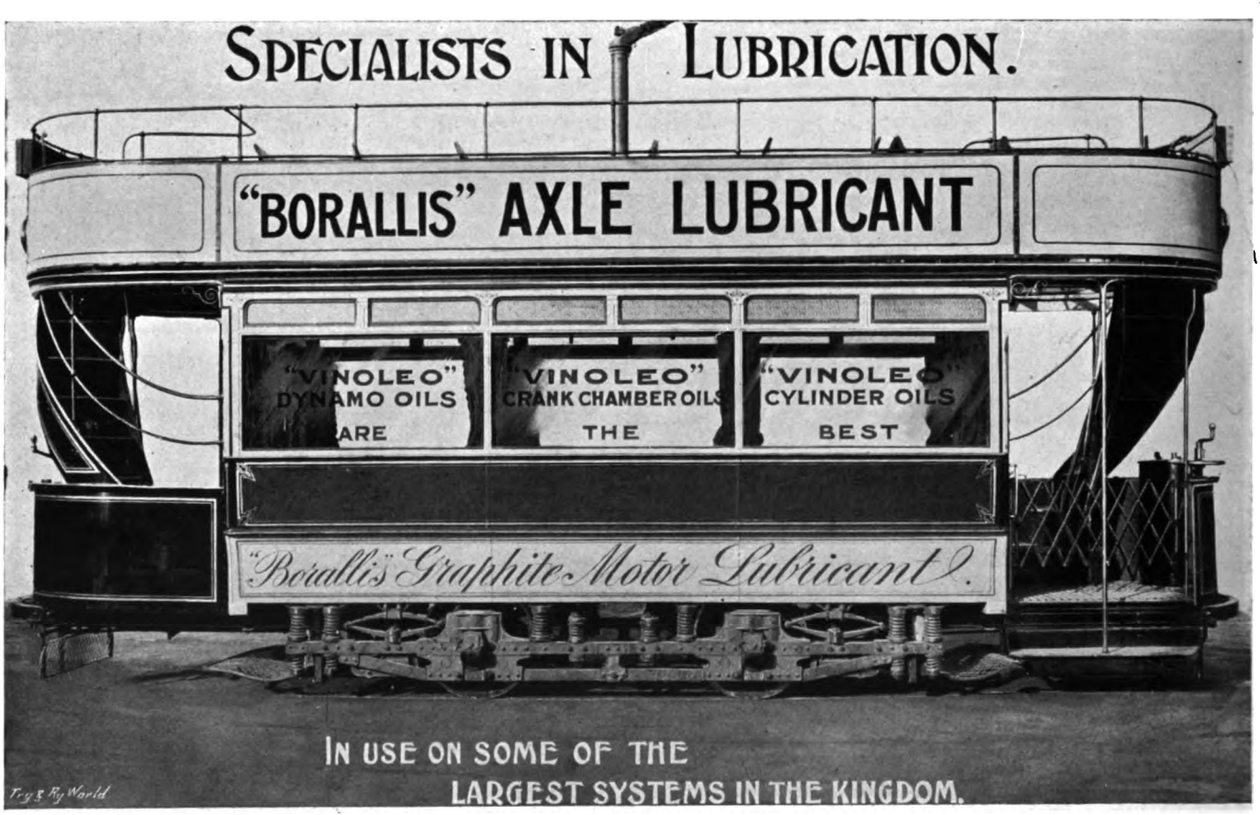

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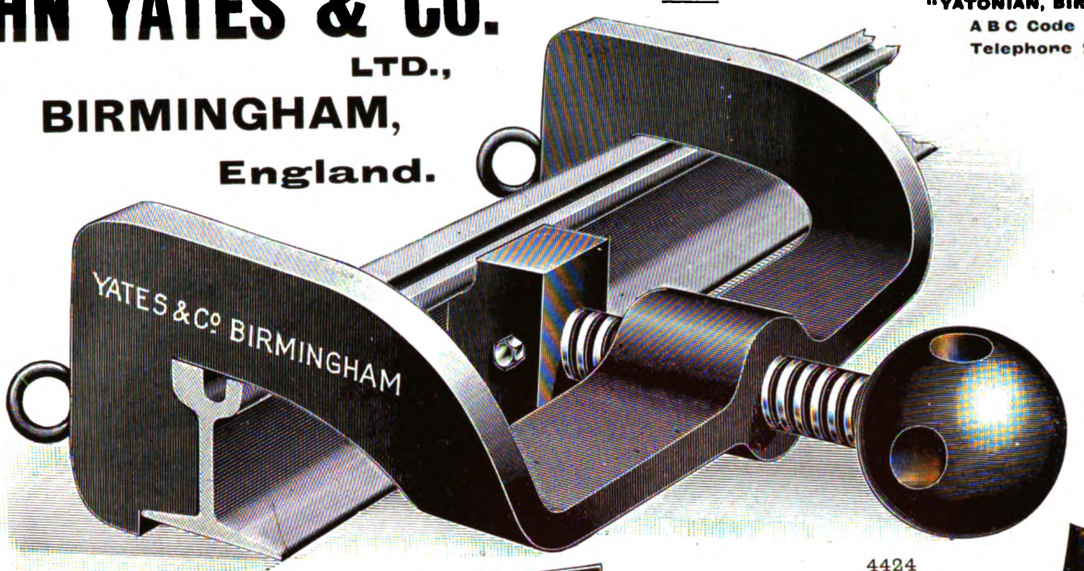

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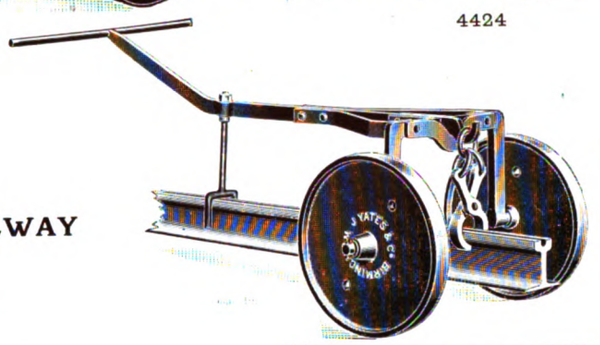
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TRAMWAY & RAILWAY

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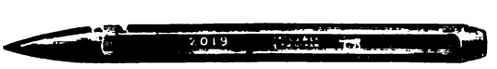
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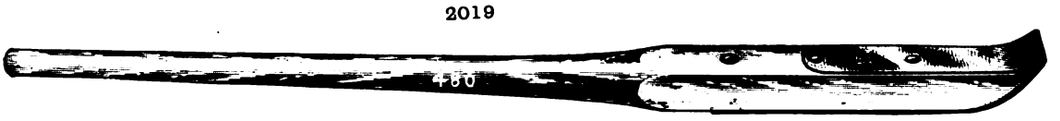
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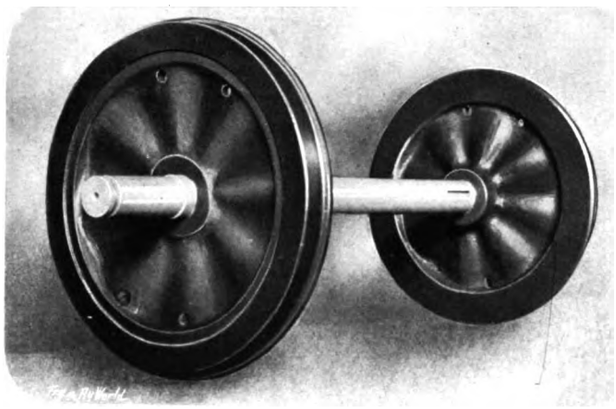

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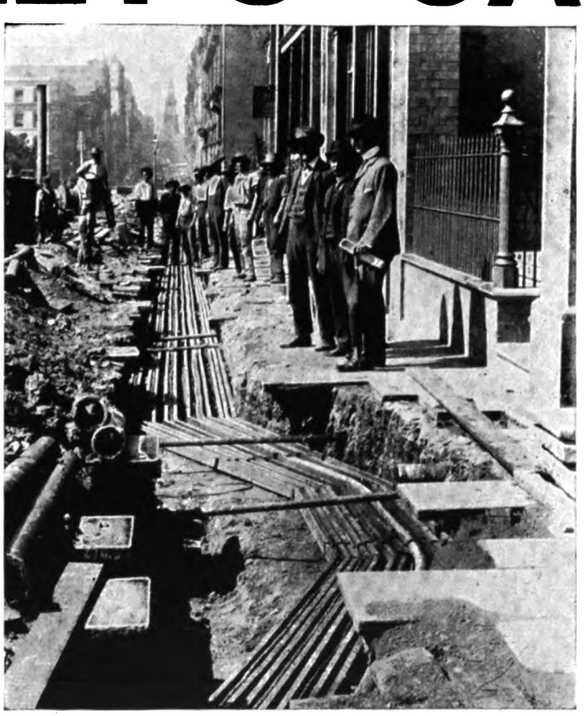

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Electric Tramways and Railways in the United Kingdom ... xxix, xxx, xxxiii, and xxxiv.
Electric Tramway Directory ... ... xxxvi, xxxix, xl, xlii, xliv, xlvi, xlviii, and l.
Directory of Tramway Directors in the United Kingdom ... ... lii, liv, and lvi.

ELECTRIC TRAMWAYS & RAILWAYS IN THE UNITED KINGDOM.

Location of Line and Name of Operating Company.	Date of Opening of First Section.	Length of Route.	Total length of Track.	Gauge.		Weight and Type of Rail.	Maximum Gradient.	Sharpest Curve.	No of Motor Cars.	No of Dynamos	How Driven.	No. of Engines	Type of Engines	Total H.P.	Contractors for Electrical Apparatus.
TRAMWAYS.				ft.	in.	lbs.	1 in	ft. rad.							
ABERDEEN Corporation	Dec., 1899	14·25	25·5	4	8½	98 G	13·2	44	69	*5	D-C.	5	V. Cp. C.	..	Macartney, McElroy & Co.
ABERDEEN Suburban Trys. Co. ..	June, 1904	5	5	4	8½	95 G	..	..	6	..	..	..	..	..	J. G. White & Co. Brush Co.
AIRDRIE & COATBRIDGE Tramway Co.	Feb., 1904	3·5	4·75	4	8½	94 G	14	220	12	..	..	..	..	..	Brush Co.
ASHTON-UNDER-LYNE Corporation ..	Aug., 1902	7·25	11·5	4	8½	98 G	10	40	12	5	..	5	..	..	Dick, Kerr, & Co. Siemens Bros.
ASTON Manor Corporation	Nov., 1904	4·11	8·11	3	6	102 G	15	37	16	5	D-C.	5	..	..	Brush Elec. Co.
AYR Corporation	Sept., 1901	6	8	4	8½	90 G	21	45	17	*2	D-C.	2	..	600	British T-H.
BARKING Town Urban District ..	Dec., 1903	1·3	1·5	4	8½	80 G	25	44	7	3	D-C.	3	V. Cp. C.	..	Blackwell & Co.
BARNSLEY & DIST. Elec. Traction Co.	Nov., 1902	3·06	4·24	4	8½	94 G	10	66	12	6	D-C.	6	..	..	J. G. White & Co. Brush Co.
BARROW-IN-FURNESS	Feb., 1904	5·37	7·75	4	0	94 G	14	50	12	..	..	..	..	..	Brush Co. Dick, Kerr, & Co.
BATH Electric Tramways, Ltd. ..	Jan., 1904	12·5	16	4	8½	95 G	10·6	37·5	40	4	D-C.	4	H.T. Cp.	..	Westinghouse
BATLEY Corporation	Aug., 1903	3·85	5·11	4	8½	104 G	9	40	8	3	D-C.	4	..	..	B. I. W. Co. British Elc. Cr Co.
BELFAST City	Under cons.	40	80	4	8½	105 G	19	40	170	4	..	3	..	..	J. G. White & Co. Westinghouse
BESSBROOK—NEWRY (1) .. .. Bessbrook and Newry Try. Co.	Aug., 1901	3	3	3	0	41 V	80	55	2	2	B	1	Hyd.Turb.	60	Mather & Platt
BEXLEY Urban District	Oct., 1903	5·25	7·5	4	8½	90 G	14	40	16	2	..	2	V. Cp.	..	Dick, Kerr, & Co.
BIRKENHEAD Corporation	Feb., 1901	13·52	23·53	4	8½	100 G	13·5	40	60	6	D-C.	6	2 H. Cp.	2,600	Blackwell & Co. British T-H.
BIRMINGHAM Corporation	Jan., 1904	2·5	5	3	6	105 G	22	40	20	..	..	..	..	..	Dick, Kerr, & Co.
BIRMINGHAM Trys. Co., City of ..	May, 1901	16	24	3	6	97 G	16	40	56	5	D-C.	5	H.C.Cp.	..	British T-H.
BIRMINGHAM and Midland Trys. Co.	.. ..	11·12	12·87	3	6	85 & 94 G	15	31	43	6	D-C.	6	Cp.	..	Brush Co.
BLACKBURN Corporation	Mch., 1899	14	22·625	4	0	92 G	15	30	48	4	D-C.	4	V. Cp. C.	1,500	British T-H. Blackwell & Co.
BLACKPOOL Corporation	Oct., 1885	9	15·19	4	8½	80 G	20	36	61	6	D-C.	4	Stm.Turb.	1,290	Elwell-Parker British T-H.
Blackpool & Fleetwood Tramroad Co.	July, 1898	9	15	4	8½	56 V 96 G	26	80	31	5	D-C.	5	V. Cp.	800	Mather & Platt Dick, Kerr, & Co.
BLACKPOOL and FYLDE Light Ry. Co.	Under cons.	14	14·5	4	8½										
BLACKPOOL—St. Anne's & Lytham ..	May, 1903	7·5	13·7	4	8½	90 G	28	45	30	..	..	..	..	..	British T-H.
BOLTON Corporation	Nov., 1899	25	40	4	8½	94 to 98 G	14	35	86	*6	D-C.	4	V. Cp. C.	3,500	Dick, Kerr, & Co. Blackwell & Co.
BOOTLE Corporation	May, 1900	4·125	8·75	4	8½	95 G	20	40	55	8	D-C.	8	..	..	Blackwell & Co
BOURNEMOUTH Corporation (2) ..	July, 1902	10·15	16·75	3	6	100 G 66 slot	9	50	54	4	D-C.	4	..	2,200	J. G. White & Co.
BOURNEMOUTH & POOLE (see Poole)															
BRADFORD Corporation	July, 1898	53	95	4	0	102 G	10	40	239	11	D-C.	11	V. Cp. C.	3,000	Westinghouse Blackwell & Co.
BRAY and ENNISKERRY Railway Co.	Under cons.	3·25	5	3	6										
BRIGHTON Corporation	Nov., 1901	9·75	17·75	3	6	101 G	10	40	50	3	D-C.	3	V. Cp. C.	1,080	Macartney & Co. Westinghouse Blackwell & Co.
BRIGHTON BEACH (1) .. .. .. Mr. Magnus Volk	Aug., 1883	1·5	1·75	2	8½	35 V	110	200	8	2	B	1	Gas	20	Siemens Bros.
BRISTOL—Bristol Trys. Co.	Oct., 1895	29	51	4	8½	92½ G	10	28	232	6	D-C.	8	V. Cp. C.	3,000	British T-H. and Blackwell & Co.
BURNLEY Corporation	Mch., 1901	10·75	19·75	4	0	102 G	9·8	35	46	*7	D-C.	7	H. Cp. C.	..	British T-H.
BURTON-ON-TRENT Corporation ..	Aug., 1903	5·63	8·74	3	6	90 G	11	40	20	3	D.C.	3	V. Cp.	..	Dick, Kerr, & Co. Blackwell & Co.
BURY Corporation	June, 1903	10·5	16	4	8½	102 G	15	50	28	3	..	..	..	..	Westinghouse
CAMBORNE and REDRUTH	Nov., 1902	3·75	4·9	3	6	90 G	15	40	8	5	D.C.	4	Cp.	345	Dick, Kerr, & Co. British T-H.
CARDIFF Corporation	May, 1902	16	31	4	8½	100 G	23	35	130	6	D-C.	6	V. Cp. C.	2,000	British T-H. Dick, Kerr, & Co.
CARLISLE, City of, Elec. Try. Co. ..	June, 1900	7·25	8·5	3	6	83 G	20	30	15	4	D-C.	4	..	600	Dick, Kerr, & Co.
CARSTAIRS	1889	1·25	1·25	2	6	..	70	..	2	1	B				
CHATHAM & DISTRICT Light Rly. Co.	June, 1902	9·33	17·19	3	6	92½ G	9	35	35	4	D-C.	4	V. Cp.	1,552	British T-H. Co. Brush Co.
CHELTENHAM and DISTRICT ..	Aug., 1901	6	6	3	6	83 G	8	40	12	..	..	..	..	..	Westinghouse
CHESTER Corporation..	April, 1903	2·5	4·75	3	6	94 G	30	40	12	*6	D-C.	6	V. Cp. C.	1,800	Blackwell & Co. British T-H.
CHESTERFIELD Corporation	Dec., 1904	3·5	4·5	4	8½	96 G	20	48·5	12	4	..	4	V.Cp. C.	..	Milnes & Co. Westinghouse Brush
CLONTARF and HILL OF HOWTH ..	July, 1900	5·5	6·5	5	3	87 G	13	34	12	..	..	..	..	..	W.M. Murphy & Co.
COLCHESTER Corporation	Aug., 1904	5	6·75	3	6	95 G	12	43	16	6	..	9	V. Cp.	..	Dick, Kerr & Co. J. G. White & Co.
COLNE and TRAWDEN Light Railway	Nov., 1903	3·5	3·7	4	0	102 G	13	60	7	..	..	..	..	..	Blackwell & Co. Glover & Co.
CORK Elec. Try. & Lighting Co. ..	Dec., 1898	9·89	15	2	11½	83 G	13	28	35	*6	D-C.	6	H.Cp. C.	1,350	British T-H. Blackwell & Co.
COVENTRY Electric Tramways Co. ..	Dec., 1895	3·25	15·75	3	6	65 G 84 G	16	40	30	4	2 D-C 2 B	4	H.Cp.C.	600	Westinghouse† Blackwell & Co.
CROYDON Corporation	Sept., 1901	10·71	17·13	4	8½	95·5 G	20	40	60	*3	D-C.	3	..	2,000	British T-H. Co.

(1) Third rail system. (2) Combined trolley and conduit system.

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ELECTRIC TRAMWAYS AND RAILWAYS—*continued.*

Location of Line and Name of Operating Company.	Date of Opening of First Section	Length of Route.	Total Length of Track.	Gauge.	Weight and Type of Rail.	Maximum Gradient.	Sharpest Curve.	No. of Motor Cars	No. of Dynamos	How Driven.	No. of Engines	Type of Engines.	Total H.P.	Contractors for Electrical Apparatus.
TRAMWAYS—*continued*				ft. in.	lbs.	1 in	ft. rad.							
Darlington Corporation	May, 1904	5	9	3 6	90 G	14	60	16	..	..	..	..	..	Westinghouse Milnes & Co.
Darwen Corporation	Oct., 1900	4·36	7·25	4 0	95 G	9	35	14	*4	D-C.	4	H. Cp.	1,500	British I. W. British T-H.
Derby and Ashbourne	Under cons.	14·5	..	4 8½										
Derby Corporation	Sept., 1904	6·75	11·75	4 0	95 G	17	45	25	3	..	3	..	..	J. G. White & Co. Brush Co.
Devonport & District Try. Co., Ltd.	June, 1901	8·5	15·5	3 6	92 G	18	30	25	*	..	..	..	..	Blackwell & Co.
Devonport Corporation	June, 1901	..	7	3 6	97 G	10	50	12	..	..	..	..	..	Blackwell & Co.
Doncaster Corporation	June, 1902	9·9	11·52	4 8½	94c. G	25	45	25	4	D-C.	4	..	750	Blackwell & Co.
Dover Corporation	Sept., 1897	3·5	4·5	3 6	87 G	25·7	44	17	*2	D-C.	2	H.CC.	240	Dick, Kerr, & Co. Blackwell & Co.
Douglas—Port Soderick .. .. Douglas Southern Elec. Trys. Co.	Aug., 1896	3·75	3·75	4 8½	65 V	12	45	8	2	B	2	H. Cp.	260	Westinghouse British T-H. Blackwell & Co.
Dublin & Lucan Elec. Railway Co.	April, 1900	6·75	6·875	3 6	50 V	20	27	5	2	D-C.	2	H.Cp.C.	400	Dick, Kerr, & Co.
Dublin United Tramways Co. ..	May, 1896	47·55	92·5	5 3	92 G	12·37	34·5	293	6	D-C.	6	V.Cp.C.	5,000	Dick, Kerr, & Co. Blackwell & Co. British T-H.
Dudley and Stourbridge Trys. British Electric Traction Co.	July, 1899	21·25	27·22	3 6	90 G	11	50	57	4	D-C.	4	H. Cp.	400	British T-H. Blackwell & Co.
Dundalk	Under cons.	6	6·25	3 6	97 G	10	50	12						
Dundee Corporation	July, 1900	12·5	23·1	4 8½	94 G	10	33	54	5	D-C.	5	..	2,226	Blackwell & Co.
East Ham Urban District	June, 1901	6·75	11·5	4 8½	90 G	25	40	35	5	D-C.	5	H. Cp.	500	Dick, Kerr, & Co.
Eccles Corporation	May, 1902	5	7·75	4 8½	102 G									
Erith Urban District Council ..	Under cons.	5	8·75	4 8½	100 G	20	40	14	2	..	5	..	..	Brush Co. Westinghouse Co.
Exeter Corporation	April, 1905	5·5	7	3 6	90 & 92 G	11·5	35	12	*4	D-C.	4	H. Cp.	..	Dick, Kerr, & Co.
Farnworth Urban District	Jan., 1903	4·33	7·16	4 8½	98 G	29	36	13	4	D-C.	4	..	3,000	
Gateshead and District	May, 1901	11·28	17·30	3 8½	90 G	8	35	50	..	..	..	..	..	Dick, Kerr, & Co. Blackwell & Co.
Giant's Causeway Elec. Try. Co. ..	Sept., 1883	8	9	3 0	42 V 75 G	24	30	6	2	B	2	Hyd. Turb.	64	Siemens Bros. British T-H.
Glasgow Corporation ..	Oct., 1898 April, 1901	78·5	147	4 7¾	100 G	14	31	683	12	D-C.	12	V. Cp.	11,600 (*b*)	British T-H. Westinghouse Macartney & Co. Blackwell & Co.
Glossop Urban District	Aug., 1903	4·5	5	4 8½	90 G	14	40	6	2	D.C.	3	..	..	British T-H.
Gloucester Corporation Light Rly.	May, 1904	9	15	3 6	90 G	25	40	30	2	..	2	C.	..	Brush Co. Dick, Kerr, & Co.
Gravesend and Northfleet ..	Aug., 1902	6·5	9·5	4 8½	87 G	11	55	18	3					
Great Crosby	June, 1900	2·5	2·5	4 8½	92½ G	..	45	14	7	D-C.	7	..	..	Dick, Kerr, & Co. Blackwell & Co.
Great Grimsby	Dec., 1901	6	10·11	4 8½	96 G	15	26	36	2	D-C.	..	..	..	Dick, Kerr, & Co.
Greenock and Port Glasgow ..	Oct., 1901	7·75	15	4 7¾	90 G	15	38	36	*					
Guernsey Railway Co.	Nov., 1892	2	3	3 8½	74 V 84 G	60	60	9	2	B	2	Cp. C.	160	Siemens Bros., & British T-H.
Halifax Corporation	June, 1898	35·5	49	3 6	95 G	9·7	40	96	*7	D-C.	7	H. Cp.	1,200	Electric Cons. Co. British T-H.
Hampshire Light Railway (Elec.) Co.	March, 1903	6	9	4 8½	..		..	10	2					
Hartlepool Electric Tramways Co.	May, 1896	6·72	8·30	3 6	87 G	15	35	21	4	D-C.	4	V. Cp.	240	Electric Cons. Co. Dick, Kerr, & Co. Macartney, & Co. Blackwell & Co.
Hastings and District	Under cons.	19·25	30·25	3 6	..	..	..	..	..	..	..	..	..	Dick, Kerr, & Co.
Herne Bay Pier .. .. Herne Bay Pier Co., Ltd. (1)	Mch., 1899	·75	·75	3 0	20 V	..	..	3	1	B	1	Gas	83	British T-H. Blackwell & Co.
Houghton-le-Spring	Under cons.	..	20	4 8½	..	..	..	..	..	..	..	..	..	Dick, Kerr, & Co.
Huddersfield Corporation	Feb., 1901	28	35	4 7¾	98 G	11	35	70	3	D-C.	3	V.Cp.C.	1,000	British T-H. Greenwood & Batley, Blackw'll & Co.
Hull Corporation	July, 1899	13	26	4 8½	94 G	20	30	116	5	D-C.	5	V.Cp.C.	1,410	Siemens Bros. & Co. British T-H., & Westinghouse
Ilford Urban District	Mar., 1903	6·5	10·5	4 8½	100 G	13	40	22	5	D-C.	5	..	2,200	Macartney & Co. British T-H., & Dick, Kerr, & Co.
Ilkeston Corporation	May, 1903	3·5	4·0	3 6	90 G	12·5	28	13	1	D-C.	1	..	..	Dick, Kerr, & Co.
Ipswich Corporation	Nov., 1903	10·8	14·9	3 6	90 G	11·5	40	36	3	D-C.	3	..	..	Westinghouse
Isle of Man—														
Manx Elc. Try. Co. Douglas to Ramsey ..	July, 1894	18	35·75	3 0	62½ V	24	90	42	10	D-C	11	V. Cp.	500	Mather & Platt
Manx Elc. Try. Co. Snaefell Mountain (1)	Aug., 1895	4·5	9·5	3 0	56 V	12	90	7	10	D-C.	11	H. Cp.	600	Mather & Platt
Isle of Thanet Elec. Trys. & Ltg. Co., Ltd.	April, 1901	9	11	3 6	90 G	11	30	60	4	D-C.	4	2 V. Cp. 2 H. Cp	1,200	British T-H. Blackwell & Co.
Kearsley Urban District	Jan., 1902	1·75	1·75	4 8½	95 G	20	..	..	..	..	..	..	..	Westinghouse
Keighley Corporation	Oct., 1904	3·5	6·25	4 0	95 G	25	60	10	3	D-C.	3	..	..	Blackwell & Co.
Kidderminster—Stourport British Electric Traction Co.	May, 1898	4·5	4·75	3 6	75 G	14	45	13	5	D-C.	5	V. Cp.	400	Brush Co. Brush Elc. Eg. Co.
Kilmarnock Corporation	Dec., 1904	4·25	4·75	4 8½	90 G	24	45	11	2	D-C.	2	..	..	Blackwell & Co.
King's Norton & Northfield U. D	May, 1904	2·75	3·25	3 6	105 G	15	100	..	..	..	..	..	..	Blackwell & Co.
Kinver	April, 1901	4	4	3 6	63 & 90 G	..	..	6						
Kirkcaldy Corporation	Feb., 1903	5·25	7·5	3 6	87 G	11	45	22	5	D-C.	5	..	910	British T-H. Co. Milnes & Co.
Lanarkshire Tramway Co. ..	July, 1903	8·63	15·08	4 7¾	96 G	11·5	36	25	4	D-C.	4	3 H. Cp. 1 V. Cp.	..	British T-H. Co.
Lancashire Light Railway Co. ..	June, 1902	3·41	3·625	4 8½	100 G	20	50	7	..	..	..	..	..	B. I. W. Co.
Lancaster Corporation	Jan., 1903	3·75	4·75	4 8½	90 G	10	35	10	4	..	4	V. Cp.	..	Milnes & Co. Greenwood & Batley, Ltd.
Leeds Corporation	Aug., 1897	42·5	81·5	4 8½	100 & 105 G	11	32	245	5	D-C.	6	H. Cp.C	4,050	Elec. Con. Co. Greenwood & Batley, British T-H. Blackwell & Co.

(1) Third rail system.

(*Continued on page* xxxiii.)

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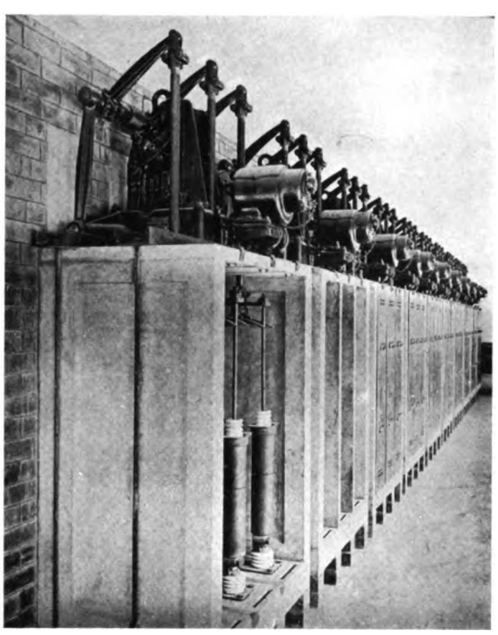
The British Thomson-Houston Company, Limited.

ELECTRICAL ENGINEERS AND MANUFACTURERS.

MOTOR OPERATED OIL SWITCHES.



B.T.H. Motor-operated Oil Switches, controlling 4 generators and 6 feeders, at Lister Drive Generating Station, Liverpool Corporation.

USED BY:

Newcastle Electric Supply Co.
Manchester Corporation Tramways.
Glasgow Corporation Tramways.
Etc., etc.

Liverpool Corporation.
Metropolitan Tramways.
Underground Electric Railways Co., of London, Ltd.

Head Office and Works: RUGBY.

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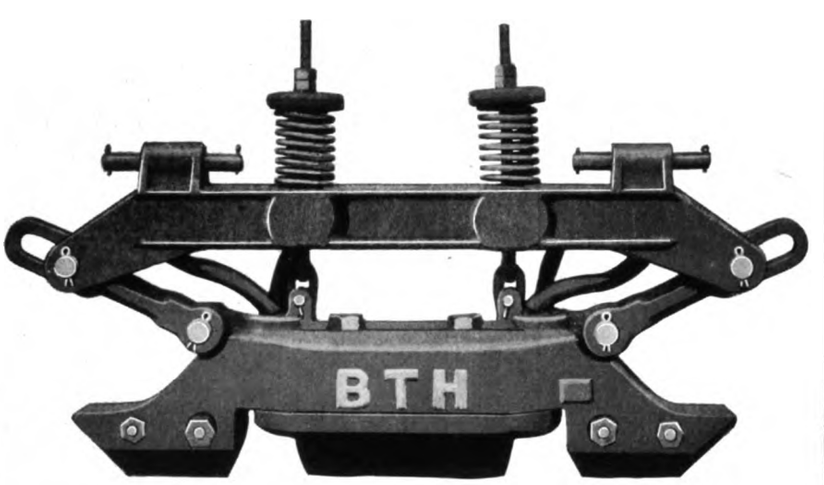
The British Thomson-Houston Company, Limited.

ELECTRICAL ENGINEERS AND MANUFACTURERS.

B.T.H. ELECTRO-MAGNETIC TRACK BRAKE



ADVANTAGES.

- Accurate control is ensured even on wet or greasy rails.
- The action of the track brake is in no way connected with the wheel brakes.
- Skidding is eliminated.
- Maintenance costs are reduced to a minimum.
- Gradients can be coasted at a uniform and safe speed.
- All apparatus is of the simplest possible character.

For the sure and safe control of tramcars.

PROVED BY TESTS TO BE MORE EFFICIENT THAN ANY OTHER FORM OF BRAKE AT PRESENT IN USE.

Head Office and Works: RUGBY.

B T-H

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ELECTRIC TRAMWAYS AND RAILWAYS—*continued from page* xxx.

Location of Line and Name of Operating Company.	Date of Opening of First Section.	Length of Route.	Total length of Track.	Gauge.	Weight and Type of Rail.	Maximum Gradient.	Sharpest Curve.	No. of Motor Cars.	No. of Dynamos	How Driven.	No. of Engines	Type of Engines.	Total H.P.	Contractors for Electrical Apparatus.
TRAMWAYS—*continued.*				ft. in.	lbs.	1 in	ft. rad.							
Leicester Corporation	May, 1904	19·25	35·5	4 8½	100 G	16	40	99	3	D-C.	3	V. Cp.C.	..	Dick, Kerr, & Co. Blackwell & Co.
Leigh Corporation	Under cons.	4·5	7·75	4 8½	..	..	..	37	..	..	..	..	..	Westinghouse Brush Co.
Leith Corporation	Under cons.	6	12	4 8½	106·7 G	19	54	36	4	D-C.	4	..	..	S. Dixon & Son Brush Co.
Lincoln Corporation (3)	Under cons.	1·75	3	4 8½	100 G	..	..	8	8	..	8			Blackwell & Co.
Liverpool Corporation	Nov., 1898 / June, 1899	57	103	4 8½	95 G	14	40	479	18	D-C.	18	V. Cp. Trip Exp.	8,400	British T-H. Dick, Kerr, & Co. Westinghouse
Liverpool Overh'd Ry. (Trol.Ln.Ex.)	June, 1900	2·5	2·5	4 8½	92½ G	Nil	45	14	7	D-C.	7	..	..	Dick, Kerr, & Co.
Liverpool—Prescot Light Railway	June, 1902	3	3·5	4 8½	100 G	20	50	7	..	..	..	..	..	B. I. W. Co.
Llandudno, Colwyn Bay, & Rhyl	Under cons.	2	8·5	3 6	86 G	13	..	16	..	..	..	..	..	Smith, F. W., & Co.
London County Council (2)..	May, 1903	46·75	84·75	4 8½	104 G	22	45	400	4	D-C.	4	V. Cp. C.	..	Dick, Kerr, & Co. Westinghouse J. G. White (Track)
London United Tramways Co. ..	April, 1901	37·09	62	4 8½	92½ G	19	32	300	5	D-C.	5	V. Cp.	4,000	British T-H. Westinghouse. Blackwell & Co.
Lowestoft Corporation	July, 1903	4·75	5·39	3 6	100 G	27	36	19	5	..	3	..	..	Blackwell & Co.
Maidstone Corporation	July, 1904	2	2·25	3 6	95 G	14	45	7	5	D-C.	5	..	..	Dick, Kerr & Co.
Manchester Corporation	June, 1901	85·5	149·5	4 8½	102 G	14·9	35	493	*25	D-C.	25	..	57,300	Macartney, McElroy & Co. British T-H. Dick, Kerr, & Co.
Merthyr	April, 1901	2·98	3·94	3 6	90 G	10	38	15	4	D-C.	4	H.S.V.	1,200	Dick, Kerr, & Co.
Metropolitan Electric Trys., Ltd.	July, 1904	15	30	4 8½	100 G	15	40	150	3	..	3	..	..	British T-H. Brush Co.
Middlesbro', Stockton, & Thornaby Electric Tramways Co.	July, 1898	8·5	15	3 6	92 G	17	30	60	3	D-C.	3	H. Cp.	1,350	British T-H. Blackwell & Co.
Middlesex County Council.. ..	Aug., 1904	6·5	13·25	4 8½										
Middleton Corporation	..	2·5	5	4 8½										
Middleton Electric Traction Co. ..	Mch., 1902	8·5	9·75	4 8½	98 G	18	45	27	3	D-C.	3	..	..	Glover & Co.
Musselburgh	Dec., 1904	3	5·25	4 8½	90 G	34	48	12	3	D-C.	..	..	..	B. T-H. Co., Nat. Elec. Cons. Co.
Nelson Corporation	Feb., 1902	2·75	3·5	4 0	107 G	11	40	9	4	D-C.	4	..	..	Blackwell & Co. British T-H. Co. Brush Co.
New St. Helens & District Trys. Co.	July, 1899	20·25	22	4 8½	95 G	14	35	36	*4	D-C.	4	V. Cp. C.	1,240	Westinghouse British T-H.
Newcastle Corporation	Dec., 1901	18·25	38	4 8½	101 G	13·5	35	165	5	D-C.	5	V. Cp.	7,800	Westinghouse British T-H.
Newport (Mon.) Corporation ..	April, 1903	6·5	13	4 8½	98 G	10	35	40	3	..	3	V. Cp.	..	Milnes & Co. Westinghouse
Northampton Corporation	July, 1904	5·5	9·5	3 6	90 G	17	55	20	3	..	3	..	..	Dick, Kerr, & Co.
North Shields Tramways Co. ..	Mar., 1901	..	7·75	3 6	90 G	10	36	22						Brush Co.
North Staf. Trys. (*Vide* Potteries)														
Norwich Electric Tramways Co. ..	July, 1900	14·5	19·5	3 6	65½ G	12·5	38	42	4	D-C.	4	H. T. Cp.	1,200	Westinghouse Blackwell & Co.
Nottingham Corporation	Jan., 1901.	15·5	28·75	4 8½	107 G	11·5	45	105	3	..	..	..	..	British T-H. & Dick, Kerr, & Co. Blackwell & Co.
Oldham, Ashton & Hyde Trys. Co.	June, 1899	9	9	4 8½	96 G	11	26	46	*3	D-C.	3	V. Cp. C.	1,950	British T-H. Blackwell & Co.
Oldham Corporation	Dec., 1900	22·5	34·75	4 8½	100 G	11	40	80	17	D-C.	17	..	..	Dick, Kerr, & Co.
Paisley & District Tramways Co.	June, 1904	..	14	4 7¾										
Perth Corporation	Under cons.	4	4·5	3 6	..	..	..	..	..	..	..	..	..	Blackwell & Co.
Peterborough Elec. Traction Co...	Jan., 1903	5·33	6·71	3 6	94 G	40	35	14	..	..	..	..	..	Blackwell & Co. Dick, Kerr, & Co.
Plymouth Corporation	Sept., 1899	7·25	12·25	3 6	92 G	13	35	30	3	D-C.	3	V. Cp.	1,050	Elec. Cons. Co. Westinghouse Blackwell & Co.
Plymouth, Stonehouse, and Devonport	Nov., 1901	4·3	7	3 6	84 G	11	34	14	..	..	..	..	..	Blackwell & Co. Dick, Kerr, & Co. Brill Co.
Pontypridd Urban District ..	Mar., 1905	3·75	5·5	3 6	95 G	11	35	6	3	..	3	..	..	B. I. W. Co. Blackwell & Co.
Poole & District Elec. Trac. Co. ..	April, 1901	3·75	4·5	3 6	90 G	13	45	17	..	..	..	..	..	Brush Co. Dick, Kerr, & Co.
Portsmouth Corporation	Sept., 1901	14·5	28·5	4 8½	96 G	17	35	81	4	D-C.	4	V. Cp. C.	1,600	Macartney, McElroy & Co. Dick, Kerr, & Co.
Potteries Extension .. Potteries Electric Traction Co.	May, 1899	30·7	38·4	4 0	87 G	10	56	105	7	D-C.	11	H. Cp. / V. Cp.	..	Dick, Kerr, & Co. Blackwell & Co.
Preston Corporation..	June, 1904	10	16·3	4 8½	95 G	16	42	30	2	D-C.	2	H. C. Cp.	..	Dick, Kerr, & Co.
Radcliffe Urban District ..	April, 1905	5	6·5	4 8½	100 G	15	40	..	..	..	2	V. Cp.		
Reading Corporation	July, 1903	7·25	13·25	4 0	96 G	16	40	36	4	D.C.	4	V. Cp.	..	Blackwell & Co. Dick, Kerr, & Co. Westinghouse
Rochdale Corporation	May, 1902	13·5	19·7	4 8½	103½ G	11·7	30	49	7	D-C.	7	..	..	British T-H.
Rossendale Valley..	Jan., 1899	6·5	8	4 0	90 G	14	37	12	..	..	..	..	..	Dick, Kerr, & Co. Brush Co.
Rotherham Corporation	Jan., 1903	7·75	9·33	4 8½	88½ G	10·5	45	30	8	D-C.	8	..	1,260	Dick, Kerr, & Co.
Rothesay	Aug., 1902	4·81	9·62	3 6	94 G / 77 G	23	120	20	3	D-C.	3	H. & V.	1,000	Dick, Kerr, & Co. Westinghouse
Ryde Pier, Isle of Wight .. Ryde Pier Co. (1)	Mch., 1886	·5	1	4 8½	30 V	..	..	3	2	B	2	Gas	30	Siemens Bros.
Salford Corporation	Oct., 1901	32	59·5	4 8½	103 G	20	45	160	*8	D-C.	8	V. Cp. C.	..	Westinghouse Mather & Platt
Scarborough Tramways Co. ..	May, 1904	4·5	7·25	3 6	90 G	11	35	22	2	..	2	..	..	Brush Elec. Co.
Sheerness	April, 1903	2·5	3	3 6	94 G	..	45	8	3	D-C.	3	..	..	Siemens & Halske Brush Co.

(1) Third rail system. (2) Conduit system. (3) G.B. surface contact system.

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ELECTRIC TRAMWAYS AND RAILWAYS—*continued.*

Location of Line and Name of Operating Company.	Date of Opening of First Section.	Length of Route.	Total Length of Track.	Gauge.	Weight and Type of Rail.	Maximum Gradient.	Sharpest Curve.	No. of Motor Cars.	No. of Dynamos	How Driven.	No. of Engines	Type of Engines.	Total H.P.	Contractors for Electrical Apparatus.
TRAMWAYS—*continued.*				ft. in.	lbs.	1 in	ft rad.							
Sheffield Corporation	Sept., 1899	35·75	65·75	4 8½	108½ G	9·5	36	250	7	D-C.	7	3 H.Cp. 4 V.Cp.	2,500	British T-H.
Shipley Urban District	May, 1902	6	10	4 0	90 G	15	..	.	3	..	..	..	..	British T-H.
Southampton Corporation	Jan., 1900	9·5	16·5	4 8½	86 G	11	35	49	7	D-C.	7	H.Cp.C.	..	Westinghouse Macartney & Co.
Southend Corporation	Aug., 1901	6·36	7·5	3 6	87 & 90 G	18	48	22	5	D-C.	5	..	..	British T-H.
Southend Pier (1) .. .. .. Southend Corporation	Aug., 1890	1·5	1·5	3 6	60 G	Lev.	18	16	2	B	2	H. Cp.	66	Crompton. British T-H.
South Lancashire Tramways Co...	Oct., 1902	19·375	25·375	4 8½	90 G	15	50	45	5	D-C.	5	C. C. V.	2,575	Blackwell & Co.
Southport Corporation	July, 1900	8·5	10·75	4 8½	87 & 90 G	25	45	26	3	D-C.	3	H. Cp.	600 kw	Macartney & Co.
Southport Electric Tramway Co...	July, 1901	9·121	9·78	4 8½	87 G	Nil	40	21						Dick, Kerr, & Co.
South Shields Corporation ..	Under cons.													
South Staffordshire	Jan., 1893	18·98	29·50	3 6	97 & 99 G	17	46	46	3	R.	3	C. H. C.	375	Blackwell & Co. E. C. C.
Stalybridge, Hyde, Mossley, and Dukinfield	May, 1904	18	24·5	4 8½	99 G	12	40	40	3	..	3	..	2,250	
Stockport Corporation	Aug., 1902	10·36	17	4 8½	96 G	10	40	30	3	D-C.	3	..	900	Macartney & Co. Dick, Kerr, & Co.
Sunderland Corporation	June, 1900	10·87	19·54	4 6	96 G	14	35	64	*4	D-C.	4	..	1,500	Dick, Kerr, & Co.
Sutton & Howth (G.N.R., Ireland)	June, 1901	5·75	6·75	5 3	72	16·7	300	10	3	D-C.	3	..	..	British T-H. Westinghouse
Swansea Tramways Company ..	June, 1900	5·5	8·5	4 8½	86 G	22	40	55	4	D-C.	4	H.Cp.C.	660	British T-H. Blackwell & Co.
Swindon Corporation	Sept., 1904	3·7	4·14	3 6	105 G	14	37	9	3	..	3	..	..	Dick, Kerr & Co. J. G. White & Co.
Taunton and West Somerset ..	Aug., 1901	1·25	1·5	3 6	90 G	25	40	6	..	..	..	..	..	Blackwell & Co.
Torquay Tramways (4)	Under cons.													
Trafford Park Estates, Ltd. (Trys.)	July, 1903	2·5	2·75	4 8½	100 G	..	35	7	3	D.C.	2	TandCp.	..	Westinghouse Btsh.Elec.CarCo.
Tynemouth and District	Mar., 1901	4·25	7·3	3 6	90 G	10	30	22	3	D-C.	3	..	..	Blackwell & Co.
Tyneside Tramways & Tramroads Co.	Sept., 1902	8·91	12·66	4 8½	95 G	10	40	24						
Wakefield & District Lgt. Rlys. Co.	Aug., 1904.	15·139	24·723	4 8½	96 G	15·6	36	55	3	D-C.	2	..	..	Dick, Kerr, & Co.
Wallasey Urban District	Mch., 1902	8·5	11·85	4 8½	98 G	14	45	30	*7	D-C.	3	V. Cp. C.	1,190	Lanc. Dynamo Co. Ferranti Blackwell & Co.
Walsall Corporation	Jan. 1904	12	16	3 6	92 G	18	56	28	7	D-C.	7	H. Cp.C.	300	British T-H. Electric Cons. Co.
Walthamstow & District Light (Electric) Railway	June, 1905.	9	9·75	4 8½	100 G	20	40	32	4	..	4	WhgGas	..	Westinghouse Henleys, W. T.
Walton-on-Naze Pier	Aug., 1898	·5	·5	3 6	36 V	..	..	3	2	D-C.	2			Blackwell & Co.
Warrington Corporation	April, 1902	6	8·5	4 8½	90 G	27	50	21	5	D-C.	5	V.C.	..	British T-H. Bruce Peebles&Co
West Bromwich Corporation ..	Dec., 1902	9	18·5	3 6	98 G	17	50	25	..	D-C.	7	..	1,050	Dick, Kerr, & Co. B. I. W. Co.
West Ham Corporation	Feb., 1904	9·75	17	4 8½	100 G	20	40	50	3	D-C.	3	V.C.Cp.	..	Milnes & Co. Brush Co.
West Riding of Yorkshire ..	Under cons.	..	14	4 8½	96 G									
Weston-super-Mare	May, 1902	2·9	3	4 8½	90 G	25	40	12	4	D-C.	4	Cp.	600	Blackwell & Co. British T-H. Brush Co.
Wigan Corporation	March, 1901	25	35	3 6 / 4 8½	100 G	12	45	67	6 *	..	7	..	..	Blackwell & Co.
Wolverhampton Corporation (3) ..	April, 1902	12	20	3 6	96 G	19	..	40	5	D-C.	5	H.Cp.C.	..	Lorain Steel Co. British T-H. Electric Cons. Co
Wolverhampton District	April, 1901	14·75	19	3 6	90 G	20	40	30	..	..	..	..	..	B.I.W. & B.T-H. Westinghouse
Worcester Electric Traction Co. ..	Feb., 1904	5·75	8·25	3 6	94 G	13	45	15	3	..	3	..	..	Brush Co. Dick, Kerr, & Co.
Wrexham and District	April, 1903	4	4·38	3 6	97 G	9	47	10	6	..	..	..	..	British T-H. & Brush Co.
Yarmouth Corporation	June, 1902	4	6	3 6	90 G	27	48	14	2	..	2	..	600	Brush Co. B.I.W. Co.
Yorkshire Electric Trys. Synd. Ltd.	Aug., 1904	15·1	24·7	4 8½	94 G	15	36	30	3	D-C.	3	..	..	Dick, Kerr, & Co.
Yorkshire Woollen District ..	March, 1903	19·25	30	4 8½	..	..	..	58	9	..	..	..	..	Brush Co. Dick, Kerr, & Co.
RAILWAYS.														
London:														
Baker St. & Waterloo Rly. Co.	Under cons.													
Central London Rly. Co. (1) ..	July, 1900	6·5	13	4 8½	100 V	..	..	32	6	D-C.	6	H. Cp.C.	6,800	British T-H.
Charing Cross, Euston, and Hampstead Railway ..	..	..	8	4 8½										
City & South London Rly. Co. (1)	Dec., 1890	6	12	4 8½	60 V / 80 V	30	120	52 loco. car'g's	7	D-C.	7	2 H.C. 4 V.C.	4,000	Mather & Platt Elec. Cons. Co. Siemens Bros. Crompton & Co.
Gt. Northern & City Rly. Co. (2)	Feb., 1904	3·75	7·5	..	..	..	..	35	6	D-C.	6	..	..	British T-H.
Great Northern, Piccadilly & Brompton Rly. Co. ..	Under cons.	8	..	4 8½										
Metropolitan Railway (2)	Jan., 1904	26	..	4 8½	..	..	..	..	3	D-C.	3	Turbine	15,000	Westinghouse
Metropolitan District Railway (and running powers) (2)	Under cons.	41	..	4 8½	..	..	..	180	8	D-C.	8	Turbine	60,000	British T-H. Westinghouse
Waterloo and City Rly. Co. (1)	July, 1898	1·5	3	4 8½	..	60 up, 30 down	..	..	6	D-C.	6	V. C.	..	Siemens Bros. Dick, Kerr & Co.
Lancashire and Yorkshire (1) ..	Mch., 1904	30	..	4 8½	..	..	..	..	..	..	..	..	..	Dick, Kerr, & Co.
Liverpool Overhead Rly. Co. (1)	Mch., 1893	6·75	13·50	4 8½	56 V	40	445·50	46	7	R.&D-C	7	H.Cp. V.Cp.	3,600	Blackwell & Co. Electric Cons. Co Dick, Kerr, & Co.
Mersey Railway (1)	April, 1903	4	8	4 8½	86	27	..	24	5	D-C.	7	V.Cp.	4,000	Westinghouse Elec. & Mfg. Co.
North Eastern Railway (1) ..	Mch., 1904	35	..	4 8½	..	..	..	..	..	..	..	..	..	British T-H. Co.

(1) Third rail system. (2) Third and fourth rails system. (3) Lorain surface contact system. (4) To be equipped on the Doulter surface contact system.

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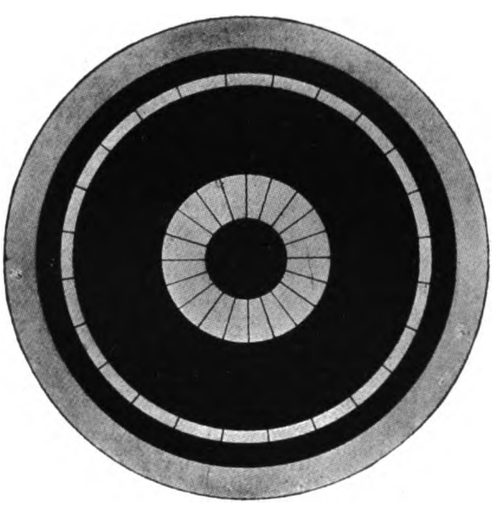

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ELECTRIC TRAMWAY DIRECTORY.

SPECIALLY COMPILED FOR

THE TRAMWAY AND RAILWAY WORLD.

MUNICIPAL TRAMWAYS, Pages xxxvi-xliv. COMPANY TRAMWAYS, Pages xlvi-lii.

MUNICIPAL TRAMWAYS.

Aberdeen Corporation Tramways, 4, Broad Street, Aberdeen. *Manager*, D. Moonie; *Traffic Manager*, J. D. Caird; *Elec. Eng.*, J. Alex. Bell; *Per. Way Eng.*, Wm. Dyack; *Chairman Try. Com.*, Dean of Guild Lyon.

■ Dec., 1899; 14·25 mi. route; 25·5 mi. track; S.G.; 98 lb. G.; max. grad. 1 in 13·2; min. radius, 44 ft.; span wires, side and centre poles; 00 wire; fixed trolley; contrs. for overhead equip., B.I.W., and Macartney, McElroy and Co.; feeders, B.I.W., Anchor Cable Co., and St. Helen's Cable Co.; 69 d. deck 4-wheel cars (25 with top covers); car bodies, British Electric Car Co. and Brush; motors, Westinghouse 25 h.p.; trucks, Brill. Current from the Corporation Elec. Works at 1·35d. per unit; generators, 5 direct current, 1 Bruce-Peebles, 3 Mason and Coulson, 1 Westinghouse; engines, 3 Willans & Robinson and 2 I.E.E., 200 h.p.; boilers, 6 B. & W. (total, 1,440 kw.) [2-5]

Ashton-under-Lyne Corporation Tramways, Tramway Depot, Mossley Road, Ashton. *Manager and Resident Eng.*, Arthur Coveney; *Cons. Elec. Eng.*, Neville Appelbee; *Per. Way Eng.*, J. T Earnshaw; *Chairman Try. Com.*, Coun. T. Hallam; *Vice-Chairman*, Coun. E. C. Bainbridge.

■ Aug., 1902; 7·25 mi. route; 11·5 mi. track; S.G.; 98 lbs. G.; max. grad., 1 in 10; min. radius, 40 ft.; side and centre poles; 000 wire; swivel trolley; contrs. for overhead equip., Macartney, McElroy & Co.; feeders (paper lead covered), W. T. Henley and Callender's; 6 d. deck and 6 s. deck cars (total 12, with 4-wheel trucks); car bodies, Dick, Kerr & Co.; motors, Dick, Kerr & Co., 25 h.p.; trucks, Brill 21 E. Current from the Ashton Corporation Lighting Station at 1½d. per unit. Generators, 5 2-pole and 3 multipolar, P. R. Jackson and Siemens Bros.; engines, 3 Browett-Lindley and 2 Belliss; boilers, 4 Lancs. and 2 multitubular; (total 1,250 kw.) [4-5]

Aston Manor Corporation Tramways, Aston. *Gen. Manager:* J. A. Lycett; *Traffic Manager:* R. W. Cramp; *Elec. Eng.:* A. J. Lawson; *Consulting Eng.*, Robert Green; *Chairman*: Ald W. Evans, J.P.

(Leased to the City of Birmingham Tramways Co.)

■ June, 1904; 4·11 mi. route; 8·11 mi. track; 3 ft. 6 in.; 102 lb. G.; max. grad. 1 in 15; min. radius, 37 ft.; side pole; 00 wire; swivel trolley; contrs., Brush Electrical Engineering Co. and George Trentham; feeders, B.I.W.; 10 d. deck and 6 s. deck, all 4-wheel cars; car bodies, Brush Co.; motors, Brush Co., 25 and 30 h.p.; trucks, Brush Co. Power obtained from the Corp. Elec. Dept. at 1·75d. per unit; generators, 2 Dick Kerr, 1 Westinghouse, and 2 G.E.C.; engines, 3 Ferranti, 1 Bellis, 1 Reavell; boilers, 6 B. & W. 2 by 96; economisers, Green's; stokers, Vicars; total, 1415 kw., and 750 on order. [4-5]

Ayr Corporation Tramways, Town Building, Ayr. *Gen. Manager and Elec. Eng.*, William Grant; *Convener Try. Com.*, Coun. J. S. Hunter.

■ Sept., 1901; 6 mi. route; 8 mi. track; S. G.; 90 lb. G.; max. grad., 1 in 21; min. radius, 45 ft.; side and centre poles; 000 wire; swivel trolley; contrs. for overhead equip., Lowdon Bros.; feeders, Callender's (solid, duplicate); 17 d. deck 4-wheel cars; car bodies, Hurst, Nelson & Co.; motors, B.T-H. 25 h.p. G.E. 52; Hurst-Nelson trucks. Current from Corporation Elec. Works, (1½d. and 1d. per unit); generators, 2 Bruce-Peebles; engines, Belliss enclosed high speed; boilers, Stirling Boiler Co.; total 400 kw. [2-5]

Barking Town Urban District Tramways, East Street, Barking. *Manager and Elec. Eng.*, A. H. Seabrook; *Con. Eng.*, C. C. Hawtayne; *Chairman Try. Com.*, L. Crow.

■ Dec., 1903; 1·3 mi. route; 1·5 mi. track; S.G.; 80 lb. G.; max. grad., 1 in 25; min. radius, 44 ft.; side poles and flexible suspension; 0 wire; swivel trolley; contrs. for overhead equip., R. W. Blackwell & Co.; feeders, Henley's (laid solid); 7 d. deck 4-wheel cars (4 with top covers); car bodies, Brush; motors, B.T-H. 25 h.p.; trucks, Peckham. Current from Corp. power-station (at 1½d. per unit, including all lighting); generators, Thames Ironworks Co. and Siemens; engines, Allen's vert. comp. conds.; boilers, 4 B. & W.; total, 200 kw. [2-5]

Batley Corporation Tramways, Batley, Yorks. *Chairman Try. Com.*, Ald. G. Hirst; *Vice-Chairman*, Coun. Bagshaw.

(Leased to British Electric Traction Co., Ltd.)

■ Aug., 1903; 8·86 mi. route; 5·11 mi. track; S.G.; 104 lb. G.; max. grad., 1 in 9; min. radius, 40 ft.; span and bracket; 00 wire; swivel trolley; contrs. overhead equip., B.I.W. Co.; feeders, Callender's; 8 d. deck 4-wheel cars; car bodies, British Elec. Car Co.; motors, Westinghouse 35 h.p.; trucks, Brill 21 E. Current from Corp. elec. works at 1½d. per unit. Generators, 3 4-pole J. Fowler & Co.; engines, 3, Belliss & Morcom and 1 350 kw. triple expansion Belliss-Westinghouse set; boilers, 3, Lancs., Clayton & Sons; total, 450 kw. [2-5]

Belfast City Tramways, Tramway Depôt, Sandy Row, Belfast. *Gen. Manager*, Andrew Nance; *Traffic Manager*, R. M. Master; *Elec. Eng.*, V. A. H. M'Cowen; *Per. Way Supt.*, T. Lewis; *Car Works Supt.*, A. A. Blackburn; *Cons. Engs.*, Lacey, Sillar, and Leigh. *Chairman Try. Com.*, Sir D. Dixon, Bart.; *Vice-Chairman*, Ald. W. Harper.

■ Under cons.; 40 mi. route; 80 mi. track; S.G.; 105 lbs. G.; max grad., 1 in 19; min. radius, 40 ft.; 0000 wire; contrs. for complete equipment, J. G. White & Co.; 170 d. deck 4-wheel cars; car bodies, Brush Co.; motors, Westinghouse; trucks Brill, type 21 E. Brush Co. makers; current from tramways and electricity dept.; generators, 3 1,000 kw., Westinghouse; engines, 3, Fairbairn, Lawson, Combe, Barbour Ltd.; boilers, 4 Lancs. [1-5]

Bexley Urban District Council Tramways, Car Sheds, Bexleyheath, Kent. *Gen. Manager and Elec. Eng.*, C. Mittelhausen; *Station Supt.*, H. Know; *Cons. Engs.*, Mordey and Dawbarn; *Chairman Try. Com.*, W. V. Hudson, J.P.; *Vice-Chairman*, G. Sheldon.

■ Oct., 1903; 5·25 mi. route; 7·5 mi. track; S.G.; 90 lb. G.; max. grad., 1 in 14; min. radius, 40 ft.; side poles and span; 0 wire; swivel trolley; contrs. overhead equip., Dick, Kerr & Co.; feeders bitumen, Anchor Cable Co.; 16 d. deck 4-wheel cars; car bodies, Dick, Kerr and Co.; trucks, max. traction, Brush Co.; motors, Dick-Kerr 25 h.p. enclosed. Generators, Dick, Kerr & Co., 2 150 kw. 4-pole, with Hart Accumulator Co.'s battery, and Highfield booster; engines, Browett, Lindley & Co., 2 225 b.h.p comp. vert. enclosed; boilers, J. Fraser & Son, 3, Lancs.; total, 300 kw. [2-5]

Birkenhead Corporation Tramways, Laird Street, Birkenhead. *Gen. Manager*, W. Wyld; *Borough Elec. Eng.*, W. Bates; *Borough Sur. and Eng.*, C. Brownridge; *Chairman Try. Com.*, Dr. H. Laird Pearson; *Vice-Chairman*, Ald. T. Cook.

■ Feb., 1901; 13·52 mi. route; 28·58 mi. track; S.G.; 100 lb. G.; max. grad., 1 in 13½; min. radius, 40 ft.; bow-string suspension side and centre poles; 0·4 wire; swivel trolley; contrs. for overhead equip., Blackwell & Co.; feeders, Callender, solid; cars, 46 d. deck and 14 s. deck (29 with bogies and 31 with single trucks, total 60); car bodies, G. F. Milnes & Co.; trucks, Peckham and McGuire; motors, Witting (T.2) and B.T-H. 25 h.p. (15 cars have 4 motors). Current from own power stations at ·797d. per unit. Generators (Crompton, Siemens, Scott and Mountain), 6 multipolar; engines, 4 Willans & Robinson and 2 Scott & Mountain, compound vertical, high speed; boilers, 7 Lancashire, Tetlowes'; total, 1,475 kw. [2-5]

Birmingham Corporation Tramways, 254A, Corporation Street, Birmingham. *Gen. Manager*, A. Baker; *Elec. Eng.*, C. W. Hill; *City Eng.*, J. Price; *City Elec. Eng.*, R. A. Chattock; *Chairman Try. Com.*, Ald. C. G. Beale; *Vice-Chairman*, Ald. W. Cook.

■ Jan., 1904; mi. route; mi. track; 3 ft. 6 in.; 105 lb. G.; max. grad., 1 in 22; min. radius, 40 ft.; side pole, bracket arm, and flexible suspension; 0000 wire; swivel trolley; feeders, Callender's, solid; 20 d. deck bogie cars; car bodies, Electric Rly. and Try. Carriage Works; motors, Dick, Kerr and Co., 27 h.p.; trucks, Brill, max. traction. Current from Aston Manor elec. works at 1½d. per unit. [2-5]

Blackburn Corporation Tramways, 9, Railway Road, Blackburn. *Joint Manager and Chief Engineer*, Leonard Johnston; *Joint Manager*, J. H. Cowell; *Car Shed Supt.*, H. W. Seymour; *Chairman Try. Com.*, Ald. W. Thompson; *Vice-Chairman*, Coun. A. Nuttall.

■ March, 1899; 14 mi. route; 29·625 mi. track; 4 ft.; 92 lb. G.; max. grad., 1 in 15; min. radius, 30 ft.; span wire, centre pole, and side bracket arms; 0·324 wire; swivel trolley; feeders, Glover (lead covered paper); 48 d. deck bogie cars; car bodies, G. F. Milnes & Co.; trucks, Brill and Peckham; motors, 8 cars with 2 25 h.p. Siemens, and 40 cars with 4 20 h.p. B.T-H. Current from Corp. elec. works at 1½d. per unit. Generators, Siemens and Mavor Coulson; engines, Belliss; boilers, Lancashire (total 800 kw.) [2-5]

Blackpool Corporation Tramways, Blundell Street, Blackpool. *Gen. Manager*, John Lancaster; *Elec. Eng.*, C. Furness; *Per. Way Eng.*, J. S. Brodie; *Chairman Try. Com.*, Ald. J. Brodie, J.P.; *Vice-Chairman*, Ald. J. Grime, J.P.

■ Oct., 1885; 9 mi. route; 15 mi. track; S.G.; 96 lb. G.; max. grad., 1 in 20; min. radius, 36 ft.; side pole and span; 000 wire; swivel trolley; feeders, B.I.W. And St. Helens Cable Co.; 61 d. deck (36 bogie and 25 4-wheel) cars; car bodies, Milnes and others; trucks, Hurst, Nelson, & Co., max. traction; motors, B.T-H. (G.E. 52) 27 h.p. Current from the Corp. elec. works at 1½d.; generators, Parson's turbines (total 600 kw.) [2-5]

Bolton Corporation Tramways, Bradshawgate, Bolton. *General Manager and Elec. Eng.*, A. A. Day; *Traffic Supt.*, C. C. Howard; *Per. Way Eng.*, E. Ll. Morgan (Borough Surveyor); *Chairman Try. Com.*, Ald. J. Miles; *Vice-Chairman*, Ald. J. Harwood.

■ Nov., 1899; 25 mi. route; 40 mi. track; S.G.; 98 lb. G.; max. grad., 1 in 14; min. radius, 35 ft.; bracket arms, span wire and centre poles; 0 wire; swivel trolley; contrs. for overhead equip., B.T-H. Co.; feeders, paper insulated, B.I.W.; cars, 86 d. deck (38 bogie and 58 4-wheel, 9 with top covers); car bodies, Dick Kerr & Co., and Brush; trucks, Brill (21E and max. traction); motors, Dick, Kerr & Co. and Westinghouse 25 and 35 h.p. Current from Electricity Committee at 1·10d. per unit; generators, 4 Mather & Platt and 2 Dick, Kerr & Co.; engines, Musgrave, cross compound; boilers, 13 Lancashire (Hick, Hargreaves, Musgrave); total 3,800 kw. [2-5]

Bootle Corporation Tramways, Electricity Works, Pine Grove, Bootle (tramways worked by Liverpool Corp.) *Elec. Eng.*, T. D. Clothier; *Chairman Try. Com.*, Coun. H. E. Wright; *Vice-Chairman*, Coun. E. Hughes.

■ May, 1900; 4·125 mi. route; 7·75 mi. track; S.G.; 95 lb. G.; max. grad. 1 in 20; min. radius, 40 ft.; brackets and flexible suspension; 000 wire; swivel trolley;

(*Continued on page xxxix.*)

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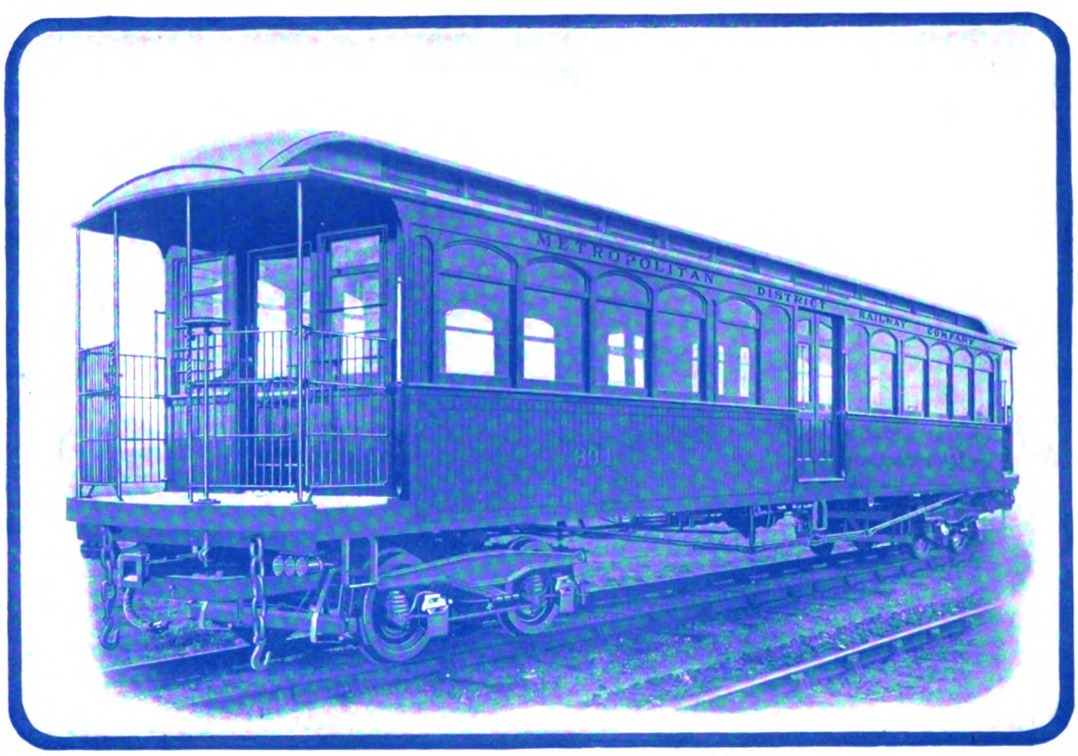
BRUSH

ELECTRIC



CARS

THE BRUSH ELECTRICAL ENGINEERING Co Ld.

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HEAD OFFICES:- 106 to 112 BELVEDERE ROAD, LONDON, S.E.

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BRUSH

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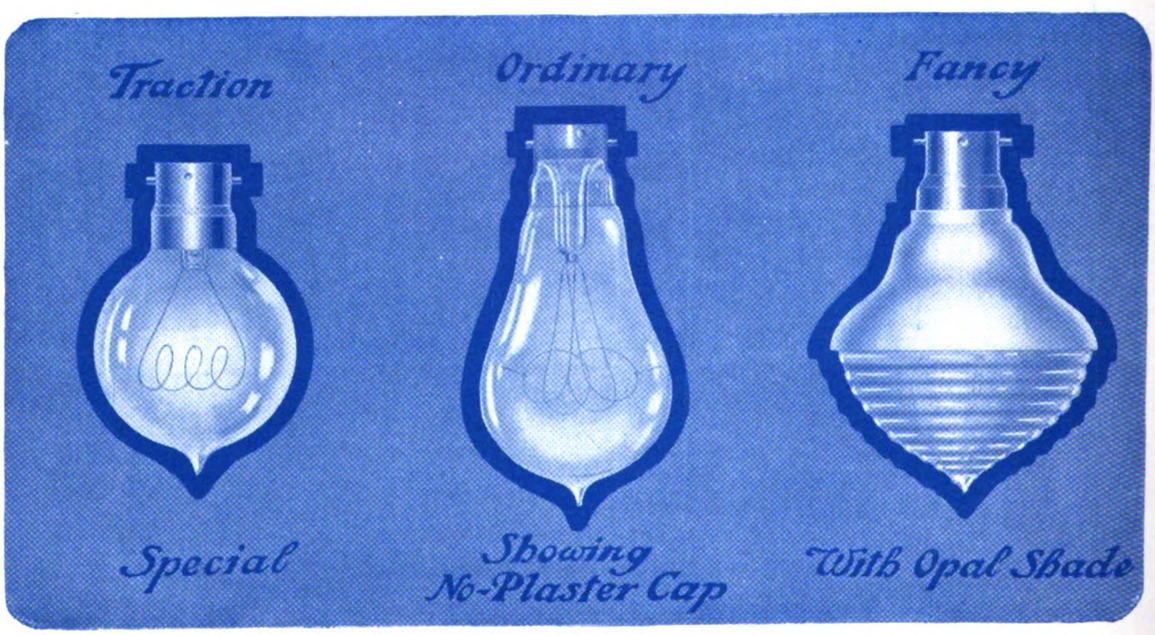

LAMPS

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ELECTRIC TRAMWAY AND RAILWAY DIRECTORY—*continued.*

contrs. for overhead equip., R. W. Blackwell & Co.; feeders, Callenders; 55 d. deck cars; current for working cars on the Bootle lines is supplied to the Liverpool Corp. from Bootle Corp. elec. works at 1½d. per unit to 875,000, 1d all excess; generators, 5 Parker, 1 E.C.C., 2 Bruce-Peebles; engines, 6 Belliss, 2 Ferranti; boilers, Lancashire, 3 Danks, 1 Heaton, 4 Yates & Thom; total 2,050 kw. [2-5]

Bournemouth Corporation Tramways, Tramways Offices, Lansdowne Crescent, Bournemouth. *Engineer and Traffic Manager*, C. Barber; *Boro.' Elec. Eng.*, I. Bulfin; *Chairman Try. Com.*, Ald. G. J. Lawson; *Vice-Chairman*, Coun. F. J. Bell.

E July, 1902; 10·15 mi. route; 16·75 mi. track; 3 ft. 6 in.; 100 lb. G. & 66 lb. slot rail; max. grad. 1 in 9; min. radius, 50 ft.; centre pole, bracket arm and span wire; also a section of conduit arranged for working in connection with trolley lines; contrs. for conduit and overhead equip., J. G. White & Co.; 00 wire; swivel trolley; feeders. Callender's (lead covered in earthenware ducts); 53 d. deck and 1 s. deck cars (28 with 4-wheel and 26 with bogie trucks); car bodies, G. F. Milnes & Co.; trucks, Brill (max. traction) and Peckham (equal wheel); motors, Westinghouse 49 B, 30 h.p. Current from Corp. elec. station, cost per unit, 1·11d.; generators, 4 B.T-H. multipolar D-C.; engines, 4 Belliss; boilers, 4 Lancs. (Dank & Co.); total 1,168 kw. [2-5]

Bradford Corporation Tramways, Central Office, 15, Bridge Street, Bradford. *Gen. Manager*, C. J. Spencer; *Traffic Manager*, F. Schofield; *City Elec. Eng.*, A. S. Blackman; *City Eng.*, J. H. Cox; *Per. Way Eng.*, J. Taylor; *Chairman Try. Com.*, Coun. Jas. Hill; *Vice-Chairman*, Ald. Enoch Priestley.

E July, 1898; 53 mi. route; 95 mi. track; 4 ft.; 102 lb. G; max. grad., 1 in 10; min. radius, 40 ft.; span wire and bracket arm; 000 wire; swivel trolley; contrs. for overhead equip., Blackwell & Co., Macartney, McElroy & Co.; feeders, B.I.W.; 238 d. deck with 4-wheels and 1 s. deck bogie truck cars; car bodies, G. F. Milnes & Co. and Brush; trucks, Peckham and Brush; motors, Westinghouse and Witting Bros., 30 h.p. Current from Electric Lighting Committee, at 1d. per unit; generators, 4 Siemens', 2 E.C.C., 2 Bruce Peebles, 3 Westinghouse multipolar; engines, 8 Willans, 2 Cole, Marchant, and Morley, 1 Musgrave & Sons; boilers, 14 B. & W., 6 Brown & Co. and Laird Bros.; total 5,490 kw. [2-5]

Brighton Corporation Tramways, Lewes Road, Brighton. *Manager and Elec. Eng.*, *Chairman Try. Com.*, Ald. H. Carden.

E Nov., 1901; 9·75 mi. route; 17·75 mi. track; 3 ft. 6 in.; 101 lb. G.; max. grad., 1 in 10; min. radius, 40 ft.; centre, side pole and span; 000 wire; swivel trolley; contrs. for overhead equip., R. W. Blackwell & Co. and Corporation; feeders, Western Electric Co., St. Helens Cable Co., and B.I.W. (lead covered); 50 d. deck 4-wheel cars; car bodies, Dick, Kerr & Co. and G. F. Milnes & Co.; trucks, Peckham, Brill; motors, 35 h.p., Westinghouse and Witting Bros., and Dick, Kerr & Co.; Current from Corp. lighting station at 1½d. per unit; generators, 3 D.C. Bruce Peebles; engines, 3 Willans & Robinson; boilers, B. & W.; total 675 kw. & 325 kw. storage battery. [2-5]

Burnley Corporation Tramways, Queen's Gate, Burnley. *Gen. Manager*, Henry Mozley; *Borough Elec. Eng.*, R. Birkett; *Boro. Surveyor*, G. H. Pickles; *Chairman Try. Com.*, Ald. Wm. Armistead; *Vice-Chairman*, Councillor J. Catlow.

E March, 1901; 10·75 mi. route; 19·75 mi. track; 4 ft.; 102 lb. G; max. grad., 1 in 9·8; min. radius, 35 ft.; span wire and bracket arm; 000 wire; swivel trolley; contrs. for overhead equip., R. W. Blackwell & Co; feeders, B.I.W. (lead covered); 38 d. deck and 8 s. deck bogie cars; car bodies, G. F. Milnes & Co., Dick, Kerr & Co.; trucks, Brill (max. traction) and G. 27; motors, B.T-H. 37 h.p. and Dick-Kerr 25 h.p. (8 cars with 4 motors). Current from the Electricity Committee at 1½d. per unit; generators, 7 2 and 4 pole E.C.C. and Dick-Kerr: engines, 3 hor. Burnley Ironworks and 4 vert. Belliss & Morcom; boilers, 5 Lancs. 28 ft. by 7 ft., with Underfeed Stokers; total 750 kw. [12-4]

Burton-on-Trent Corporation Tramways, Guild Street, Burton-on-Trent. *Gen. Manager & Elec. Eng.*, P. J. Pringle; *Traffic Manager*, R. S. Pilcher; *Cons. Engs.*, Kincaid, Waller, Manville, and Dawson; *Chairman*, Coun. J. S. Rowland; *Vice-Chairman*, Ald. T. E. Lowe.

E Aug., 1903; 5·63 mi. route; 8·74 mi. track; 3 ft 6 in.; 90 G.; max. grad., 1 in 11; min. radius, 40 ft.; side poles and span wire; 000 wire; swivel trolley; contrs. overhead equip., R. W. Blackwell & Co.; feeders, B.I.W.; 20 d. deck 4-wheel cars (3 with top covers, Milnes, Voss type;) car bodies, Dick, Kerr & Co.; motors, Dick, Kerr 25 h.p.; trucks, Brill. Current from Electricity Committee at 2d. per unit up to 100,000 units and 1½d. afterwards; generators. 3 100 kw., B.T-H. multipolar d-c.; engines, 3 vertical, high-speed, enclosed, Willans and Robinson; boilers. Lancashire, 3 Yates & Thom, and 3 Tinkers; total 1,560 kw. (300 kw. for traction). [2-5]

Bury Corporation Tramways, Rochdale Road Depôt, Bury. *Manager*, William Clough; *Borough Eng.*, Arthur W. Bradley; *Borough Elec. Eng.* S. J. Watson; *Chairman Try. Com.*, Councillor J. Hall; *Vice-Chairman*, Councillor W. Ashworth.

E June, 1903; 10·5 mi. route; 16 mi. track; S.G.; 102 lb. G.; max. grad. 1 in 15; min. curve, 40 ft.; side brackets and span wire; 0 wire; swivel trolley; contrs. overhead equip., Macartney, McElroy & Co.; feeders, St. Helens Cable Co.; 28 d. deck 14 4-wheel, and 14 bogie truck cars; car bodies, Milnes & Co.; motors, Westinghouse 30 h.p.; trucks, McGuire. Current to be taken from Corp. elec. works at 1½d. per unit; Multipolar generators, Siemens; engines, 2 Belliss & Morcom; boilers, 2 Lancashire (total 550 kw.) [6-4]

Cardiff Corporation Tramways, Central Offices, The Hayes, Cardiff. *Manager and Elec. Eng.*, A. Ellis; *Traffic Inspector*, H. David; *Per. Way Eng.*, W. Harpur; *Chairman Try. Com.*, Councillor J. W. Courtis; *Vice-Chairman*, J. Munn.

E May, 1902; 16 mi. route; 31 mi. track: S.G.; 100 lb. G.; max. grad., 1 in 23; min. radius, 35 ft.; centre, side and span; 000 wire; swivel trolley; overhead equip., R. W. Blackwell & Co.; feeders, B.I.W. (lead covered in Doulton conduits); 100 d. deck and 30 s. deck cars (70 bogie and 60 4-wheel—total, 130 cars); car bodies, Dick. Kerr & Co, Brush and Milnes & Co.; trucks, Brill 21 E., and Brush; motors, Dick, Kerr & Co., Westinghouse and B.T.H. 25 h.p. Current from tramway power-station at ·39d. per unit; generators, 4 300 kw. Westinghouse, 2 1,100 kw. Dick, Kerr & Co.; engines, 4 500 h.p. and 2 1,600 h.p. Musgraves; boilers, 12 Lancashire, Musgraves, 30 ft. by 8 ft.; total, 1,200 kw. [2-5]

Chester Corporation Tramways, City Road, Chester. *Manager*. J. Gardner; *Elec. Eng.*, S. E. Britton; *Per. Way Eng.*, I. M. Jones; *Chairman Try. Com.*, W. Ferguson; *Vice-Chairman*, D. Hewitt.

E April, 1903; 2·5 mi. route; 4·75 mi. track; 3 ft. 6 in.; 94 lb. G.; max. grad., 1 in 30; min. radius, 40; centre pole, side pole and span; 00 wire; swivel trolley; contrs. for overhead equip., R. W. Blackwell & Co.; feeders, Callender's (solid system); 12 d. deck 4-wheel cars; car bodies. G. F. Milnes & Co.; trucks, Brill 21 E.; motors, B.T-H. Current from electric lighting dept. at 1½d. per unit; generators, 6 2-pole Thos. Parker, Ltd.; engines, 3 Belliss and Morcom 150 h.p. and 3 450 h.p.; boilers, 7 B. & W.; total, 960 kw. [2-5]

Chesterfield Corporation Tramways, Chatsworth Road, Chesterfield. *Manager and Boro. Elec. Eng.*, R. L. Acland; *Traffic Supt.*, G. B. K. Ingman; *Chairman Try. Com.*, Coun. E. Shentall; *Vice-Chairman*, Ald. J. Pearson.

E Dec. 1904; 3·5 mi. route; 4·5 mi. track; S.G.; 96 lb. G.; max. grad., 1 in 20; min. radius, 48·5 ft.; span and side arm; 0000 wire; swivel trolley; contrs. overhead equip., B.I.W. Co.; feeders, B.I.W. Co.; 12 d. deck 4-wheel cars; car bodies, Brush Elec. Eng. Co.; motors, Westinghouse 25 h.p.; trucks, Brush; generator, 4 6-pole British Westinghouse Co.; engines, 4 Belliss and Morcom; boilers, 6 B. & W.; total, 400 kw. [2-5]

Colchester Corporation Tramways, Colchester. *General Manager*, R. C. Bullough; *Elec. Eng.*, A. R. Sillar; *Per. Way Eng.*, H. Goodyear (Borough Eng.); *Chairman Try. Com.*, Coun. Marshall; *Vice-Chairman*, Ald. E. J. Sanders, J.P.

E July, 1904; 5 mi. route; 6·75 mi. track; 3 ft. 6 in.; 95 lb. G.; max. grad., 1 in 12; min. radius, 48 ft.; bracket arms and centre pole; 00 wire; swivel trolley; contrs. overhead equip., J. G. White & Co.; feeders, Henley's; 16 d. deck 4-wheel cars; car bodies, Dick, Kerr, & Co.; motors, Dick, Kerr & Co. 35 h.p.; trucks, Brill Co. Power to be obtained from the Corp Elec. Dept.; generators, 4 Bipolar, Siemens Bros., 1 Multipolar, Mather and Platt, and 1 Multipolar, Siemens Bros.; engines, Davey Paxman 6, Peache 3, compound; boilers, 4 multitubular, Davey, Paxman & Co.; total, 550 kw. [3-5]

Croydon Corporation Tramways are leased to the Croydon Tramways Company (*q.v.*)

Darlington Corporation Tramways, Haughton Road, Darlington. *General Manager and Elec. Eng.*, J. R. P. Lunn; *Traffic Manager*, C. J. O'Dowd; *Cons. Elec. Engs.*, Kennedy & Jenkin; *Chairman*, Councillor E. Wooler.

E June, 1904; 4·875 mi. route; 8·875 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad., 1 in 14; min. radius, 46 ft.; side poles; 00 wire; swivel trolley; contrs. overhead equip., British Elec. Equip. Co.; feeders, W. T. Glover & Co., paper insulated; 16 s. deck 4-wheel cars; car bodies, Milnes & Co.; motors, Westinghouse, 25 h.p.; trucks, McGuire Mfg. Co.; current from Corp. Elec. Works at 1½d. per unit; generators, 6 Scott & Mountain and 2 T. Parker, Ltd.; engines, 4 Scott and Mountain, and 2 H. Allen and Co., enclosed high speed; boilers, 4 Lancs., R. Taylor & Sons; traction battery, E P.S., 350 amp capacity; 692 kw. [2-5]

Darwen Corporation Tramways. Town Hall, Darwen. *Manager & Chief Eng.*, R. W. Smith-Saville; *Traffic Manager*, J. H. Ellison; *Chairman Try. Com.*, Coun. E. Catterall; *Vice-Chairman*, Coun. F. Hindle.

E Oct., 1900; 4·26 mi. route; 7·25 mi. track; 4 ft.; 95 lb. G.; max. grad. 1 in 9; min. radius, 35 ft.; span wire (some side arm and centre pillars); 0 wire; swivel trolley; contrs. for overhead equip., B.I.W.; feeders, B.I.W. solid; 14 d. deck cars (10 with bogie and 4 with 4 wheels, 1 with top cover); car bodies, G. F. Milnes & Co.; trucks, Brill max. traction and 21 E.; motors, Westinghouse 46 and 49 B., and B.T-H. G.E. 52, 27-30 h.p. Current from Corp. elec. works at 1½d. per unit; generators, 2 Siemens bipolar, 1 Mather & Platt and 1 Bruce Peebles multipolar; engines, 4 Belliss & Morcom; boilers, 2 Lancs., Yates & Thom; total, 900 kw. [6-5]

Derby Corporation Tramways, 4, Victoria Street, Derby. *Gen. Manager*, F. Harding; *Elec. Eng.*, T. P. Wilmshurst; *Per. Way Eng.*, J. Ward; *Chairman Try. Com.*, Ald. R. W. Spriggs.

E July, 1904; 6·75 mi. route; 11·75 mi. track; 4 ft.; 95 lb. G.; max. grad., 1 in 17; min. radius, 45 ft.; bracket and centre pole; 00 wire; swivel trolley; contrs. overhead equip., J. G. White & Co.; feeders, Callender's, solid system; 25 d. deck 4-wheel truck cars; car bodies and trucks, Brush Co.; motors, B.T-H. 25 h.p.; current supplied from Corp. Lighting Dept. at 1½d. per unit; 3 steam turbine sets by C. E. Parsons & Co.; boilers, 6 Lancs. and 5 B. & W. water tube; total for tramway, 600 kw. [2-5]

Doncaster Corporation Tramways, Grey Friars Road Doncaster. *Manager and Elec. Eng.*, E. S. Rayner: *Traffic Supt.*, R. O. Baldwin; *Per. Way Eng.*, W. H. Crabtree; *Chairman Try. Com.*, Councillor G. Smith.

E June, 1902; 9·9 mi. route; 11·52 mi track; S.G.; 100 lb. C.G; max. grad., 1 in 25; min. radius, 45 ft.; bracket arm and span wire; 000 wire; swivel trolley; contrs. for overhead equip., R. W. Blackwell & Co.; feeders, Callender's; 25 d. deck 4-wheel cars; car bodies. Dick, Kerr & Co.; trucks, Brill; motors, Dick, Kerr & Co., 25 h.p. (type A.) Current from Corp. lighting station at 1½d. per unit; generators, 2 Bruce Peebles & Co., and 2 Mather and Platt; engines, 4 Willans & Robinson; boilers, 4 Lancashire (3 Tetlow's and 1 Arnold's); total, 800 kw. [2-5]

Dover Corporation Tramways, Town Hall, Dover. *Gen. Manager*, E. Carden; *Boro. Eng.*, H. E. Stilgoe: *Chairman Try. Com.*, Sir. W. H. Crundall, J.P.; *Vice-Chairman*, Coun. F. G. Wright, J.P.

E Sept., 1897; 3·5 mi. route; 4·5 mi. track; 3 ft. 6 in.; 87 lb. G.; max. grad., 1 in 25·7; min. radius, 44 ft.; bracket suspension; 0 wire; swivel trolley; contrs. for overhead equip., Dick, Kerr & Co.; feeders, Callender's; 17 d. deck 4-wheel cars (1 with top cover); car bodies, Brush, Milnes, and Elec. Try. & Ry. Car. Works; trucks, Peckham & Brill; motors, B.T-H. and Dick-Kerr 25 h.p. Current from Dover Corp. Supply Station at 2½d. per unit; generators, 2 multipolar B.T-H.; engines, 2 Mackintosh and Seymour H.C.C.; boilers, 2 B. & W.; total, 200 kw. [2-5]

Dundee Corporation Tramways, Town House Buildings, Dundee. *Manager*, P. Fisher; *Elec. Eng.*, Jos. Shepherd; *City Elec. Eng.*, H. Richardson; *Per. Way Eng.*, W. Mackison; *Chairman Try. Com.*, Coun. W. Brownlee.

E July, 1900; 12·5 mi. route; 23·1 mi. track; S.G.; 94 lb. G.; max. grad. 1 in 10; min. radius 33 ft.; side running, principally; 00 wire; swivel trolley; contrs. for overhead equip., Blackwell, and Lowdon Bros.; feeders, Callender's; 48 d. and 6 s. deck cars (24 bogie and 30 4-wheel); car bodies, Dick, Kerr and Co., Milnes, Hurst Nelson & Co.; trucks, Brill (21 E. max. traction and 27 G.); motors, Dick, Kerr & Co., 35 h.p. (6 cars have 4 motors 25 h.p.). Current taken from the Dundee Gas Commissioners at 1½d. per unit; generators, 5 Parker, Dick, Kerr & Co. 4, 6, & 8 pole D.C.; engines, 5 Willans; boilers, 8 Lancs., Cooper & Greig, and 2 water-tube, B. & W.; total, 2,416 kw. [2-5]

East Ham Corporation Tramways, Nelson Street, East Ham. *Manager and Eng.*, W. C. Ullman: *Chairman Try. Com.*, Ald. J. Savage.

E June, 1901; 6·75 mi. route: 11·5 mi. track; S.G.; 90 lbs. G.; max. grad., 1 in 25; min. radius, 42 ft.; side arm, brackets; 0 wire; swivel trolley; contrs. for overhead equip., Dick, Kerr & Co.; feeders, Callender's; 35 d. deck 4-wheel cars (6 with top covers); car bodies, Dick, Kerr & Co.; trucks. Brill (21 E.); motors, Dick, Kerr & Co. 25A. Current taken from Corp. generating station at 1½d. per unit; generators, 5 multipolar Dick, Kerr & Co.; engines, Musgrave, 4 horizontal comp. and 1 vert.; boilers, 8 B. & W.; total, 1,975 kw. (traction, 450 kw.) [2-5]

Eccles Corporation Tramways (worked by the Salford Corporation *q.v.*) Eccles. *Elec. Eng.*, H. W. Angus; *Chairman Try. Com.*, Ald. J. Schofield; *Vice-Chairman*, Ald. W. D. Kendall, J.P.

E May, 1902; 5 mi. route; 7·75 mi. track; S.G.; 100 lb. G. [2-5]

Erith Urban District Council Tramways, District Council Offices, Erith. *Elec. Eng.*, G. E. Heath; *Cons. Engs.*, Hawtayne and Zeden.

E Under cons.; 5 mi. route; 8·75 mi. track; S.G.; 100 lb., No. 3, B.S.; max. grad. 1 in 20; min. radius, 40 ft.; 000 wire; swivel trolley; feeders, paper and lead drawn; 14 d. deck 4-wheel cars (7 with top covers); car bodies, Brush Co.; motors, Westinghouse 49 B; trucks, Mountain and Gibson; current from own power-station; generators, 3 rotary, 150 kw. each; engines, 3 Allen and 2 Belliss; boilers, Lancs., 2 Spurr, Inman and 3 Yates and Thom; total for tramways, 300 kw. [6-5]

Exeter Corporation Tramways, Town Hall, Exeter. *Chief Officer*, W. R. Hederstedt: *Elec. Eng.* H. D. Munro: *Per. Way Eng.*, T. Moulding; *Chairman Try. Com.*, E. C. Perry (Mayor).

E Under cons.; 5·5 mi. route; 7 mi. track; 3 ft. 6 in.; 90 and 92 lb. G.; max. grad., 1 in 11·5; min. radius, 35 ft.; bracket and span; 0000 wire; swivel trolley; contrs. overhead equip., Dick, Kerr & Co., Ltd.; feeders, Siemens; 12 d. deck 4-wheel cars: car bodies, Elec. Rly. & Try. Carriage Works, Ltd.; motors, Dick-Kerr, 35 h.p. 6 A; trucks, Brill 21 E. Current obtained from Lighting Works. [11-4]

Farnworth Urban District Council Tramways, Albert Road, Farnworth. *Elec. Eng.*, R. B. Leach; *Chairman Try. Com.*, Coun. W. B. Richardson.

E January, 1902; 4·33 mi. route; 7·16 mi. track; S.G.; 98 lb. G.; max. grad., 1 in 29; min. radius, 36 ft.; centre pole and span; ·324 trolley; swivel trolley; contrs for overhead equip., B.I.W. and G. Hill & Co.; feeders, lead covered, B.I.W.; 13 d. deck bogie cars; car bodies, Milnes & Co.; motors, Westinghouse 49 B 25 h.p.; trucks, Brill max. traction. Current from generating station at ½d. per unit; generators, 3 120 kw. Lancs. Dynamo Co.'s and 1 250 kw. Westinghouse; engines, 3 Browett-Lindley, 1 Bellis & Morcom; boilers, 3 E. Danks & Co.; total, 610 kw. [2-5]

Glasgow Corporation Tramways, 46, Bath Street, Glasgow. *Gen. Manager*, J. Dalrymple; *Traffic Supt.*, L. Mackinnon; *Elec. Eng.*, E. T. Goslin; *Chief Eng.*, J. Ferguson; *Chairman Try. Com.*, Hugh Alexander; *Vice-Chairman*, River Bailie Steven.

E Oct., 1898; 78·5 mi. route; 147 mi. track; 4 ft. 7¾ ins.; 100 lbs. G.; max. grad., 1 in 14; min. radius, 31 ft.; cross span with rosettes and one mile centre pole arranged for fixed under running trolleys; 00 wires;

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ELECTRIC TRAMWAY AND RAILWAY DIRECTORY—*continued.*

fixed trolley; contrs. for overhead equip., Macartney, McElroy & Co.; feeders, National Conduit Cable Co., paper insulated and lead covered; 662 d. deck 4-wheel and 21 s. deck bogie (total 683 cars); car bodies, all made in depot works except 80 by Gloucester Ry. Carr. & Wagon Co.; trucks, Brill 21 E.; motors, Westinghouse 35 h.p., 49 B., Witting Bros., B.T-H.; current from power-station through 5 sub-stations at ·53d. per unit; generators, 4 2,500 k.w. (6,500 v. three phase), 2 600 k.w. (550 v.) DC and 6 exciter B.T-H.; engines, 2 Allis, 2 Musgrave, 2 D. Stewart & Co. and W. H. Allen Sons 6 exciter; boilers, 16 B. & W., water-tube; total 11,200 kw. (and 800 kw. for exciters). [4-5]

Gloucester Corporation Light Railway, Bristol Road Depôt, Gloucester. *Gen. Manager and Elec. Eng.*, Edwin Edwards; *Per. Way Eng.*, R. Read; *Chairman Try. Com.*, Ralph Fream; *Vice-Chairman*, H. Langley Smith.

E May, 1904; 9 mi. route; 15 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad. 1 in 25; min. radius, 40 ft.; side pole; 0 wire; swivel trolley; contrs. overhead equip., British Elec. Equip. Co.; feeders, Callender's V.B.; 80 d. deck 4-wheel cars; car bodies, Brush; motors, Dick Kerr & Co., type 25 B., 30 h.p.; trucks, Brush; current supplied from corp. lighting station at 1½d. per unit; generators, 4 G.E. Co.; engines, 2 Willans & Robinson; boilers, 4 Lancashire, and 2 B. & W. (in connection with refuse destructor); total, 600 kw. [1-5]

Great Yarmouth Corporation Tramways, Caister Road, Great Yarmouth. *Gen. Manager*, F. L. Turner; *Elec. Eng.*, Gordon Bryant; *Per. Way. Eng.*, J. W. Cockrill (Borough Surveyor); *Chairman Try. Com.*, Ald. F. Arnold.

E June, 1902; 4 mi. route; 6 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad., 1 in 27; min. radius, 48 ft.; span, side and centre poles; ·409 wire; swivel trolley; contrs. overhead equip., B.I.W. Co.; feeders, Helsby; 14 d. deck 4-wheel cars; car bodies, Brush; motors, Brush 25 h.p. (1,000 A.); trucks, Brush. Current taken from Corp. Elec. Works at 2·5d. per unit; generators, 2 British Schuckert; engines, Allen & Son, 2 sets 800 h.p. each; boilers, 6 water-tube B. & W.; 400 kw. [6-4]

Halifax Corporation Tramways, Skircoat Road, Halifax. *Manager*, F. Spencer; *Elec. Eng.*, W. M. Rogerson; *Per. Way Eng.*, J. Lord; *Chairman Try. Com.*, Ald. T. Hey; *Vice-Chairman*, Coun. A. Fawcett.

E June, 1898; 35·5 mi. route; 49 mi. street; 3 ft. 6 in.; 95 lb. G.; max. grad., 1 in 9·7; min. radius, 40 ft.; centre and side poles; 00 wire; swivel trolley; feeders, Callender's and B.I.W. bitumen and lead covered; 94 d. deck and 2 s. deck 4-wheel cars (1 with top cover); car bodies, Milnes and Brush; motors, Westinghouse and B.T-H., 35 h.p.; trucks, Peckham and Brush. Current taken from Corp. Elec. Works at 1¾d. per unit; generators, 7 E.C.C.; engines, 7 Belliss and Morcom, Pollitt & Wigzell; boilers, 8 B. & W.; total, 4,000 kw. [2-5]

Huddersfield Corporation Tramways, Power Station, Longroyd Bridge, Huddersfield. *Manager & Elec. Eng.*, R. H. Wilkinson; *Traffic Assist.*, T. Hartley; *Borough Eng.*, K. F. Campbell; *Chairman Try. Com.*, Ald. T. H. Moore; *Vice-Chairman*, Coun. T. Cartwright.

E Feb., 1901; 28 mi. route; 35 mi. track; 4 ft. 7½ in.; 98 lb. G.; max. grad., 1 in 11; min. radius, 35 ft.; bracket arm and span; 00 wire; swivel trolley; contrs. for overhead equip., Blackwell & Co., B.T-H., and Macartney, McElroy & Co.; feeders, W. T. Henley (paper insulated), and B.I.W. (lead sheathed); 70 d. deck cars (11 bogie and 59 4-wheel); car bodies, Milnes & British Electric Car; motors, B.T.-H. 35 h.p. (GE. 58) and Westinghouse (49 B); trucks, Brill (max. traction) and British Elec. Car (single trucks); cost of current per unit ·39d.; generators, 2 Greenwood & Batley and 1 Mather & Platt D-C.; engines, 1 Combe-Barbour, 2 Musgrave Corliss inverted vert.; boilers, Lancs., 3 Taylors-Marsden, 1 Horsfield; total, 1,400 kw. [2-5]

Hull Corporation Tramways, Osborne Street, Hull. *Manager*, Wm. J. McCombe; *Elec. Eng.*, J. Wilkinson; *Per. Way Eng.*, A. E. White. *Chairman Try. Com.*, Ald. F. Larard; *Vice-Chairman*, Ald. Robson, J.P.

E July, 1899; 13 mi. route; 26 mi. track; S.G.; 94 lb. G.; max. grad., 1 in 20; min. radius, 30 ft.; bracket arm, bowstring, and span, 0 and 000 wire; swivel trolley; contrs. for overhead equip., Siemens Bros.; feeders, jute, lead cased in conduits; 116 d. deck cars (1 bogie and 115 single truck, 40 with top covers); car bodies, Milnes, Brill, Brush, Elec. Try. & Rly. Car. Works, Hurst, Nelson & Co.; motors, Siemens, Westinghouse, and B.T-H. 15 h.p.; cost of current per unit, ·64d.; generators, 4 Siemens, 1 International; engines, 5 Belliss-Morcom; boilers, 5 Lancashire; total 1,500 kw. [2-5]

Ilford Urban District Council Tramways, Ley Street, Ilford. *Manager*, G. R. Spurr; *Elec. Eng.*, A. H. Shaw; *Chairman Try. Com.*, Coun. B. Bailey; *Vice-Chairman*, Coun. P. F. Gaunt.

E March, 1903; 6·5 mi. route; 10·5 mi. track; S.G.; 100 lb. G.; max. grad., 1 in 13; min. radius, 40 ft.; side and centre poles; 00 wire; swivel trolley; contrs. overhead equip., Macartney, McElroy & Co., feeders, Henley's, paper, lead covered; 22 d. deck cars (6 bogie and 16 single truck); car bodies, Hurst, Nelson & Co.; trucks, Hurst, Nelson (max. traction); motors, B.T-H., 25 h.p.; Current to be taken from Council's lighting station at 1½d. per unit; generators, 3 G.E.C. and 2 Dick-Kerr; engines, 5 Willans & Robinson high-speed; boilers, 2 B. & W. & 2 Dry-back (Fraser); total 1,600 kw. (750 kw. for traction). [2-5]

Ilkeston Corporation Tramways, Park Road, Ilkeston. *Manager & Elec. Eng.*, A. C. Gilbert; *Chairman Try. Com.*, Ald. S. Robinson; *Vice-Chairman*, Councillor Richards.

E May, 1903; 3·5 mi. route; 4 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad., 1 in 12·5; min. radius, 28 ft.; side brackets and span wire; 0 wire; swivel trolley; contrs. for overhead equip., Dick, Kerr & Co.; feeders, Callender's; 13 d. deck 4-wheel cars; car bodies, Dick, Kerr & Co.; motors, Dick, Kerr & Co. 25 h.p.; trucks, Brill; current will probably be obtained from Nottinghamshire & Derbyshire Power Co., at 1½d. per unit; generator, 1 E.C.C. D-C.; engines, 1 Davey and Paxman; boilers, 3 Davy and Paxman; total, 350 kw. [6-4]

Ipswich Corporation Tramways, Constantine Road, Ipswich. *Chief Eng. and Manager*, Frank Ayton; *Traffic Manager*, W. Murray; *Chairman Try. Com.*, Coun. H. J. W. Jervis; *Vice-Chairman*, Coun W. T. Pretty.

E Nov. 1903; 10·8 mi. route; 14·9 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad., 1 in 11·5; min. radius, 40 ft.; flexible suspension from poles; 0 wire; swivel trolley; contrs. overhead equip., British Elec. Equip. Co.; feeders, Johnson-Phillips; 36 d. deck 4-wheel cars; car bodies, Brush; trucks, Brush standard; motors, Westinghouse, 25 h.p. Current to be taken from Corp. Station at 2d. per unit; generators, 3 Allgemeine Electricitats Gesellschaft; engines, 3 Reavell & Co.; boilers, 4 Danks & Co. Multitubular Marine; total 675 kw. [2-5]

Kearsley Urban District Council Tramways, Council Office, Kearsley, Farnworth, R.S.O. *Clerk U. D. C.*, H. Martin; *Chairman*, Coun. J. Openshaw; *Vice-Chairman*, G. F. Cooke.

E January, 1902; 1·75 mi. route; 1·75 mi. track; S.G.; 95 lb. G.; max. grad. 1 in 20; side and centre poles; contrs. overhead equip., B. I. W. Co. These tramways are leased and worked by Farnworth D. C. Current taken from Farnworth U. D. C. lighting station at 2d. per unit. [2-5]

Keighley Corporation Tramways, Coney Lane, Keighley. *Traffic Manager*, *Elec. Eng.*, J. M. Smyth; *Per. Way Eng.*, W. H. Hopkinson; *Chairman Try. Com.*, Coun. D. Driver; *Vice-Chairman*, Ald. J. Wakehouse.

E Oct., 1904; 3·5 mi. route; 6·25 mi. track; 4 ft.; 95 lb. G; max. grad., 1 in 25; min. radius, 60 ft.; side pole, span wire; 000 wire; swivel trolley; contrs. overhead equip., R. W. Blackwell & Co.; feeders, W. T. Glover & Co., paper and diatrine; 10 d. deck 4-wheel cars; car bodies, Brush Co.; motors, B. T-H. 30 h.p. G E. 58; trucks, Brush Co. Current from Corp. combined power-station at 1·9d. per unit, from Tramways Committee. Generators, 3 D-C. 500 volts., T. Parker, Ltd.; engines, 3 inverted enclosed, W. H. Allen, Son, & Co.; boilers, 2 Lancs., Clayton, Son, & Co.; total, 900 kw. [4-5]

Kilmarnock Corporation Tramways, Electricity Works, Kilmarnock. *Elec. Eng. and Manager*, A. H. Burbidge; *Traffic Supt.*, C. Womersley; *Consulting Engineers*, Messrs. Kennedy and Jenkins; *Convener Try. Com.*, Coun. J. B. Wilson, J.P.

E Dec., 1904; 4·25 mi. route; 4·75 track; S.G.; 90 lb. G; max. grad., 1 in 24; min. radius, 45 ft.; bracket arm and span wire; 00 wire; swivel trolley; contrs. overhead equip., R.W. Blackwell & Co.; feeders, Callender's, jute insulated; 11 d. deck 4-wheel cars; car bodies, Hurst, Nelson & Co; motors, Witting, Eborall & Co.; trucks, Hurst Nelson. Current from own station; generators, 2 Dick, Kerr & Co., D.C.; engines, 2 Belliss & Morcom; boilers, 3 Lancs., Yates & Thom; total, 240 kw. [12-4]

King's Norton & Northfield Urban District Council Tramways, 10, Newhall Street, Birmingham. *Engs.*, C. H. Gadsby and A. W. Cross; *Clerk to the Council*, E. Docker; *Chairman Try. Com.*, Coun. G. P. Underhill.

E May, 1904; 2·75 mi. route; 3·25 mi. track; 3 ft. 6 in.; 105 lb. G.; max. grad., 1 in 15; min. radius, 100 ft.; brackets with flexible suspensions; 00 wire; swivel trolley; contrs. permanent way and overhead equip., R. W. Blackwell & Co.; feeders, Callender's. [2-5]

Kirkcaldy Corporation Tramways, Electricity Works, Victoria Road, Kirkcaldy. *Manager & Elec. Eng.*, O. F. Francis; *Traffic Supt.*, Jas. Fisher; *Chairman Try. Com.*, Coun. G. Fergusson.

E Feb., 1903; 5·25 mi. route; 7·5 mi. track; 3 ft. 6 in.; 87 lb. G.; max. grad., 1 in 11; min. radius, 45 ft.; bracket arm and span wire; ·325 wire; swivel trolley; contrs. for overhead work, B.I.W. Co. and Helsby Cable Co.; feeders, Henley's; 22 d. deck 4-wheel cars; car bodies, Milnes; trucks, Milnes & Co.; motors, B.T-H. 28 h.p. Current taken from Corporation Elec. Station at 1¾d. per unit; generators, 5 Laurence Scott; engines, 5, Browett Lindley; boilers, 3, Stirling; total, 1,090 kw. [2-5]

Lancaster Corporation Tramways, Thurnham Street, Lancaster. *Manager & Elec. Eng.*, W. A. Tester. *Chairman Try. Com.*, Ald. Wm, Smith.

E Jan., 1903; 3·75 mi. route; 4·75 mi. track; S.G.; 90 lb. G.; max. grad., 1 in 10; min. radius, 35 ft.; side brackets; 000 wire; swivel trolley; contrs. for overhead equip., Lowdon Bros. and R. W. Blackwell & Co.; feeders, Callender's vulcanised bitumen; 10 d. deck 4-wheel cars; car bodies, Lancaster Carriage & Wagon Co.; trucks, Brill; motors, Westinghouse, 25 h.p. Current supplied from Corp. Elec. Works at 2d. per unit; generators, 4 Westinghouse: engines, 4 v.c. Belliss; boilers, 7 Lancashire, Foster's; total, 1,200 kw. (combined lighting and tramways). [2-5]

Leeds Corporation Tramways, Standard Buildings, City Square, Leeds. *General Manager*, J. B. Hamilton; *Traffic Supt.*, A. Daggett; *Elec. Eng.*, John Burbridge; *Chief Assist.*, H. G. Jeken; *Per. Way Eng.*, R. B. Holt; *Chairman Try. Com.*, Alderman J. Ward; *Vice-Chairman*, Coun. R. P. Beckworth.

E July, 1897; 42·5 mi. route; 81·5 mi. track; S.G.: 100 lb. & 105 lb. G.; max. grad., 1 in 11; min. radius, 32 ft.; side and centre poles; 0000 wire; swivel trolley; contrs. for overhead equip., Laing, Wharton, & Down, Blackwell & Co., B.T-H. Co. and Corporation; feeders, Glover's, Henley's, and B.I.W.; 244 d. deck and 1 s. deck (all 4-wheel cars); car bodies, Dick-Kerr, Brush, Brill (convertible), B.T-H.; motors, B.T-H. (GE. 800 and 58), Dick-Kerr (35a), Brush (800a) 25 to 37 h.p.; trucks, Peckham. Brill, Brush. Current taken from own power station at ·35d. per unit works cost; generators, 2 D-C. 750 kw. by Greenwood & Batley and 3 D-C. 800 kw. by Electric Construction Co.; engines, 3 hor. comp. condens. 90 R.P.M., Hick, Hargreaves, and 2 120 R.P.M., J. Fowler & Co., one 250 kw. turbo set by C. A. Parsons & Co.; boilers, 12 Lancs., Clayton & Co.; 4,150 kw. [2-5]

Leicester Corporation Tramways, 20 and 22, Humberstone Gate, Leicester. *Manager & Sec.*, A. F. Lucas; *Boro. & Try. Eng.*, E. G. Mawbey; *Resident Elec. Eng.*, T. R. Smith; *Chairman Try. Com.*, Coun. S. Flint; *Vice-Chairman*, Ald. T. Smith.

E May, 1904; 19·25 mi. route; 35·5 mi. track; S.G.; 100 lb. G.; max. grad., 1 in 16; min. radius, 40 ft.; flexible suspension, span and centre poles; 000 wire; swivel trolley; contrs. over. equip., R. W. Blackwell & Co.; feeders, W. T. Glover & Co.; 99 d. deck single truck cars; car bodies and equip., Dick, Kerr & Co.; trucks, 21E. Brill; motors, 25A., Dick, Kerr & Co., 40 h.p. Current taken from own power-station; generators, 3 D-C. Dick, Kerr & Co., 500 kw. each; engines, 3 Yates & Thom. vert. comp. conds.; boilers, 4 Lancs., Yates & Thom; battery, 240 cells, Tudor Accumulator Co.; 1,500 kw. [3-5]

Leigh Corporation Tramways, Town Hall, Leigh, Lancs. *Elec. Eng.*, A. T. Smith; *Surveyor*, T. Hunter; *Chairman Try. Com.*, Ald. W. J. Smith; *Vice-Chairman*, Coun. J. W. Unsworth.

E Under cons.; 4·5 mi. route; 7·75 mi. track; S.G.; 37 d. deck cars. [2-5]

Leith Corporation Tramways.—Morton Place, Leith Walk, Leith. *Gen. Manager*, John Wilson; *Elec. Eng.*, A. Peden Rutherford (*Burgh Elec. Eng.*); *Per. Way, Eng.*, J. R. Findlay (*Burgh Eng.*); *Eng. for Scheme*, Jas. More, Junr.

E Under cons.; 6 mi. route; 12 mi. track, S.G.; 106·7 lb. G.; max. grad. 1 in 19; min. radius, 54 ft.; centre and side bracket poles; 0000 wire; swivel trolley; contrs. overhead equip., B. I. W. Co., S. Dixon & Son, and Corporation; feeders, B. I. W.; 36 d. deck 4-wheel cars (6 with top covers); car bodies, Brush Co. and Elec. Rly. & Try. Carr. Works, Ltd.; motors, B. T-H. G.E. 54 and Brush Co. 1002 B. 25 h.p.; trucks, Brill, B. T-H., and Elec. Rly. & Try. Carr. Works. Current to be supplied from own Electric Light Station; generators, Crompton 2-350 kw., Silvertown 1-300 kw., Bruce Peebles 1-600 kw.; engines, 2 Jas. Howden & Co., and 2 Belliss & Morcom; boilers, B. & W. 1, and Sinclair, 6 Lancs.; total, 1,600 kw. [6-5]

Lincoln Corporation Tramways, Brayford Side North, Lincoln. *General Manager and City Elec. Eng.*, Stanley Clegg; *Chairman Try. Com.*, Coun. C. Pratt.

(Proposed electrification on the G.B. Surface Contact System).

E Under cons.; 1·75 mi. route; 3 mi. track; S.G.; 100 lbs. G.; feeders, Callenders, vulcanised bitumen; 8 double deck 4-wheel cars (2 with top covers); car car bodies, Brush Elec. Eng. Co.; motors, Westinghouse 25 h.p. and 30 h.p. 46 M. and 200; trucks, Brush radial. Current from own power-station charged to Tramways dept., at 2d. per unit; generators, 7 Laurence & Scott and 1 Bruce Peebles (compound for traction); engines, 7 Willans and 1 Howden, high speed; boilers, 4 Ruston, Procter, and 1 Tinker marine type dryback, 1 Climax water-tube, Rowland & Co.; 552 kw. [1-5]

Liverpool Corporation Tramways. 6, Sir Thomas Street, Liverpool. *General Manager*, C. R. Bellamy; *Elec. Eng.*, A. Clough; *Traffic Manager*, C. W. Mallins; *Per. Way Eng.*, J. A. Brodie; *Chairman Try. Com.*, Ald. Sir C. Petrie; *Vice-Chairman*, Ald. F. Smith.

E Nov., 1898; 57 mi. route; 108 mi. track; S.G.; 95 lb. G.; max. grad., 1 in 14; min. radius, 40 ft.; centre, side pole, and span wire; 000 wire; swivel trolley; contrs. overhead work, Blackwell & Co.; feeders, Callender's; 467 d. deck and 12 s. deck cars, 464 single truck, and 15 bogie (total, 479) 350 with top covers; car bodies, Dick, Kerr & Co.; motors, Dick, Kerr & Co., 25 and 35 h.p.; trucks, Brill. Current taken from Electric Lighting Committee at 1·12d. per unit; 18 Siemens generators; engines, 18 Willans; boilers, 42 Lancs.; 21,695 kw. [2-5]

London County Council Tramways, 303, Camberwell New Road, London, S.E. *Chief Officer*, A. L. C. Fell; *Traffic Manager*, J. K. Bruce; *Elec. Eng.*, J. H. Rider; *Rolling Stock Supt.*, J. Bowden; *Per. Way Eng.*, J. Welling; *Chairman Try. Com.*, J. A. Baker: *Vice-Chairman*, D. S. Waterlow.

E May, 1903; 46·75 mi. route; 84·75 mi. track; S.G.; 104 lb. G.; max. grad., 1 in 22; min. radius, 45 ft.; conduit system, centre slot; contrs. for conduit and track, J. G. White & Co., Dick, Kerr, & Co., and Wm. Griffiths & Co.; feeders, B.I.W. & Helsby and Siemens; 400 d. deck (200 with bogie and 200 with 4 wheels) 101 with top covers; car bodies, Elec. Rly. & Try. Car. Works, Brush Co., and British Elec. Co.; motors, Dick-Kerr and Westinghouse 35 h.p.; trucks, Brill and McGuire; generators (temporary plant pending completion of large station), 2 D-C. 600 volts and 2 3-phase 6,600 volts, 1,500 kw., Dick-Kerr generators; engines, 4 2,500 h.p. Ferranti vertical compound; boilers, Stirling water-tube, 3,000 kw.; generated by Council's own plant, steam supplied by South London Elec. Supply Corp.; price per unit, 1·40d. to 1·50d. for steam; total, 6,000 kw. [2-5]

(*Continued on page xlii.*)

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ELECTRIC TRAMWAY AND RAILWAY DIRECTORY—*continued.*

Lowestoft Corporation Tramways, Norwich Road, Lowestoft. *Manager and Elec. Eng.*, G. A. Bruce; *Cons. Eng.*, W. C. C. Hawtayne; *Chairman Try. Com.*, Coun. Lancelot F. Orde (Mayor).
E July, 1903; 4·75 mi. route; 5·39 mi. track; 3 ft. 6 in.; 100 lb G.; max. grad., 1 in 27; min. radius, 36 ft.; side poles and bracket arms; 00 wire; swivel trolley; contrs. overhead equip., R. W Blackwell & Co.; feeders, Callender's; 15 d. deck and 4 s. deck cars (4 bogie and 15 4-wheel trucks); car bodies, Milnes and Co.; motors, Westinghouse 25 h.p. No. 46; trucks, Milnes. Current from Corp. Elec. Works at 2½d. per unit; generators. 5 6 and 8 pole B.T-H. Co., and 1 Lancs. Dynamo Co.; engines. 2 Browett Lindley, 1 Willans and Robinson, and 2 Musgrave; boilers, 4 B. & W. water tube, and 1 Musgrave dryback marine; total, 1,475 kw. [2-5]

Maidstone Corporation Tramways, Fairmeadow, Maidstone. *Gen. Manager and Elec. Eng.*, E. E. Hoadley; *Per. Way Eng.*, T. F. Bunting; *Cons. Eng.*, S. Sellon; *Chairman Try. Com.*, Ald. E. Vaughan.
E July, 1904; 2 mi. route; 2·25 mi. track; 3 ft. 6 in.; 95 lb. G.; max. grad., 1 in 14; min. radius, 45 ft.; span wire and side pole; 0 wire; fixed and swivel trolleys; contrs. overhead equip., Dick, Kerr, & Co.; feeders, Henleys; 7 d. deck 4-wheel cars; car bodies, Dick, Kerr, & Co.; trucks, Brill; motors, Dick-Kerr 25 h.p. Power supplied by the Corp. Elec. Dept., 2d. first 200,000, 1¾d. next 200,000, and 1½d. afterwards; generators. 2 150 kw. Westinghouse, and 3 Parker; engines, 5 Peache high-speed, by Davey Paxman; boilers, 4 Davey Paxman, economic; total, 300 kw. [2-5]

Manchester Corporation Tramways, 55, Piccadilly, Manchester. *General Manager*, J. M. McElroy; *Traffic Sup.*, J. T. Oakes; *Elec. Eng.* (overhead equip. dept.), J. J. McMahon; *Per. Way Eng.*, H. Mattinson; *Chairman Try. Com.*, Councillor D. Boyle; *Vice-Chairman*, Councillor W. H. Wainwright.
E June, 1901; 85·5 mi. route; 149·5 mi. track; S.G.; 102 lb. G.; max. grad., 1 in 14·9; min. radius, 35 ft.; mostly span wire (some centre poles): 0·4 in. wire; swivel trolley; 467 d. deck and 26 s. deck cars, 162 bogie and 305 single truck (14 with top covers); car bodies, Milnes and Brush; motors, B.T-H. Co., Westinghouse, and Dick-Kerr 25 and 35 h.p. (25A. and 35A.); trucks, Brill, Peckham, and Brush. Current taken from Corp. Elec. Works at 1·49d. per unit. [3-5]

Middlesex County Council Light Railways, Middlesex Guildhall, Westminster, S.W., *County Eng.*, H. T. Wakelam, M.I.C.E.; *Chairman of Light Railways Com.*, Sir Francis Cory-Wright; *Vice-Chairman*, H. Nield. These Light Railways will be leased to the Metropolitan Electric Tramways, Ltd.
E August, 1904; 6·5 mi. route; 13·25 mi. track; S.G. [2-5]

Middleton Corporation Tramways. *Consulting Engs.*, Lacey, Clirehugh, and Sillar; *Chairman Try. Com.*, Ald. J. Aspell.
E (under cons.); 2·5 mi. route; 5 mi. track; S.G. (Worked by the Manchester Corporation Tramways.) [2-5]

Nelson Corporation Tramways, Charles Street, Nelson. *Manager and Elec. Eng.*, W. A. Fraser; *Boro. Surveyor*, B. Ball; *Chairman Try. Com.*, Ald. Wm. Reed.
E Tramway, Feb., 1903 (leased to Burnley Corporation 2·75), and light railway, February, 1903; 0·75 mi. tramway and 2 mi. light ry. route; 2·75 mi. tramway and 2·75 m. light ry. track; 4 ft.; 107 lb. G.; max. grad. 1 in 11; min. radius, 40 ft.; span wire and poles; 000 wire; swivel trolley; contrs. overhead equip., Blackwell & Co.; feeders, Callender's solid system; 6 d. deck 4-wheel, and 3 s. deck bogie cars (1 with top cover); bodies, B.T-H and Dick, Kerr & Co.; motors, B.T-H., Dick, Kerr & Co. 25 h.p.; trucks, Brill. Current from Corp. Elec. Works at 2d. per unit; generators. 3 200 kw. and 1 400 kw. Bruce Peebles; engines, 3 350 h.p., and 1 650 h.p. Willans and Robinson; boilers, 2 Lancs. 8 ft. by 30 ft. (E. Dank & Co.); total 600 kw. [2-5]

Newcastle-upon-Tyne Corporation Tramways, Manors, Newcastle. *Manager & Elec. Eng.*, Ernest Hatton; *Traffic Supt.*, ; *Per. Way Eng.*, F. J. Edge; *Chairman Try. Com.*, Ald. J. B. Ellis; *Vice-Chairman*, Coun. J. H. Rodgers.
E Dec., 1901; 18·25 mi. route; 38 mi. track; S.G.; 101 lb. G.; max. grad., 1 in 18·5; min. radius, 35 ft.; centre running span wire and bracket; 0·4 wire; swivel trolley; contrs. for overhead equip., B.I.W. Co.; feeders, B.I.W. Co.; 77 d. deck and 88 s. deck cars (total 165—83 4-wheel and 82 bogie); car bodies, Hurst, Nelson & Co., Brush; motors, B.T-H. Co.; (GE. 58) and Westinghouse (46 and 80); trucks, Brill (27G and 21E). Current obtained from own power-station at ·34d. per unit; generators. 4 Westinghouse, 1 Bruce Peebles; engines. 1 Willans 800 h.p., 2 Coates 1,000 h.p. each, 1 Wallsend 2,000 h.p., and 1 Coates 3,000 h.p.; boilers, 12 Lancs. (T. Beeley and Co.); 5,000 kw. [12-4]

Newport (Mon.) Corporation Tramways, Town Hall, Newport. *Manager & Elec. Eng.*, H. Collings Bishop; *Per. Way Eng.*, R. H. Haynes; *Chairman Try. Com.*, Coun. W. H. Brown; *Vice-Chairman*, Coun. T. S. Gower.
E April, 1903; 6·5 mi. route; 13 mi. track; S.G.; 96 lb. G.; max. grad., 1 in 10; min. radius, 35 ft.; span wire; 0 and 00 wire; swivel trolley; contrs. overhead equip., W. T. Glover; feeders, Henley; 40 d. deck 4-wheel truck cars; car bodies, Milnes 30, Dick-Kerr 10; motors, Westinghouse 30, Dick, Kerr & Co. 10 25 h.p. and 30 h.p.; trucks, Peckham 30, Brill 10. Current from Corp. Elec. Works, at 1½d. per unit; generators, 3 Witting Bros., slow speed; engines, 3 Markham cross compound vertical; boilers, 6 B & W.; 1,800 kw. [3-5]

Northampton Corporation Tramways. St. James', Northampton. *Manager*, J. Gottschalk; *Elec. Eng.*, J. C. McMahon; *Chairman Try. Com.*, Ald. H. Wooding; *Vice-Chairman*, Coun. H. Martin.
E July, 1904; 5·5 mi. route; 9·5 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad. 1 in 17; min. radius, 55 ft.; side pole and span; 000 wire; swivel trolley; contrs. overhead equip., Brush Elec. Eng. Co.; feeders, Siemens Bros., lead covered; 20 d. deck 4-wheel cars; car bodies, Dick, Kerr & Co.; motors, Dick, Kerr & Co., 27 h.p. enclosed; trucks, Brill, B. 27; generators, 3 International Elec. Eng. Co.; engines, Willans and Robinson, 3 vert. cond.; boilers. Davey Paxman 2 Economic; total, 520 kw. [2-5]

Nottingham Corporation Tramways, Beast Market Hill, Nottingham. *General Manager*, John Aldworth; *Traffic Supt.*, H. Morley; *City Elec. Eng.*, H. Talbot; *Per. Way Eng.*, Arthur Brown (*City Eng.*); *Chairman Try. Com.*, Ald. Brownsword; *Vice-Chairman*, Ald. Sir J. T. McCraith.
E Jan., 1901; 16·25 mi. route; 30·5 mi. track; S.G.; 107 lb. G.; max. grad., 1 in 11·5; min. radius, 40 ft.; centre and span; 000 wire; swivel trolley; contrs. overhead equip., R. W. Blackwell & Co. and Corporation; feeders, Callender's bitumen; 105 d. deck cars (16 with bogie and 89 4-wheel) 12 with top covers; car bodies, Dick-Kerr and Milnes; motors, Dick-Kerr, B.T-H., and Westinghouse, 25, 30, and 35 h.p. (10 cars with 4 motors); trucks, Brill. Current taken from Corp. Elec. Works, at 1·25d. per unit; generators, 3 Siemens; engines, Willans and Robinson; boilers, Lancashire; 2,640 kw. [3-5]

Oldham Corporation Tramways, Wallshaw Depot, Oldham. *Gen. Manager*, Lewis Slattery; *Boro.' Elec. Eng.*, S. W. Newington; *Traffic Supt.*, A. Woolstencroft; *Chairman Try. Com.*, Councillor J. S. Dronsfield, J.P.; *Vice-Chairman*, Councillor S. Dunkerley.
E Dec., 1900; 22·5 mi. route; 34·75 mi. track; S.G.; 100 lb. G.; max. grad., 1 in 11; min. radius, 40 ft.; centre pole bracket arm and span; 000 wire; swivel trolley; contrs. for overhead equip., W. T. Glover & Co.; feeders, Glover & Co., lead covered; 56 d. deck and 24 s. deck (14 bogie and 66 4-wheel trucks, 11 with top covers); car bodies, Dick, Kerr & Co.; trucks, Brill 21 E.; motors, Dick, Kerr & Co. 25 h.p. 25 A. Current taken from Corp. elec. works at 1·5d. per unit; generators, 12 Siemens & Co., 4 Hall & Co., and 1 Parsons; engines, 16 Willans & Robinson, and 1 Parsons; boilers, 8 Lancs., 8 Marine, 3 Climax; 2,750 kw. [2-5]

Perth Corporation Tramways, Town Hall, Perth. *Gen. Manager*, John Lambert; *Chairman Try. Com.*, Coun. Macnab. *Cons. Engs.*, Kincaid, Manville, Waller & Dawson.
E Under cons.; 4 mi. route; 4·5 mi. track; 3 ft. 6 in.; contrs. overhead equip. and permanent way, R. W. Blackwell & Co.; feeders, Callender's; cars and equipment, Hurst, Nelson & Co. [2-5]

Plymouth Corporation Tramways, 15, Elrington Street, Plymouth. *Manager*, C. R. Everson; *Elec. Eng.*, E. J. Okell; *Chairman Try. Com.*, Coun. R. R. Monk.
E Sept. 1899; 7·25 mi. route; 12·25 mi. track; 3 ft. 6 in.; 92 lb. G.; max. grad., 1 in 18; min. radius, 35 ft; side brackets and span wire; 00 and 0000 wire; swivel trolley; contrs. for overhead equip., Blackwell & Co.; feeders, Callender's and B.I.W.; 80 d. deck 4-wheel cars; car bodies, G. F. Milnes & Co. and Brush; motors, Westinghouse, 25 h.p.; trucks, Peckham. Current obtained from Corp. elec. works at 2d. per unit; 3 generators, Westinghouse; engines, Belliss & Morcom; boilers, 7 Lancs.; total 700 kw. [2-5]

Pontypridd Urban District Tramways, Pontypridd. *Gen. Manager and Elec. Eng.*, J. E. Teasdel; *Traffic Inspector*, W. May; *Cons. Elec. Eng.*, R. P. Wilson; *Per. Way Eng.*, P. R. A. Milloughby; *Chairman Try. Com.*, H. Bramwell.
E (under cons.); 3·75 mi. route; 5·5 mi. track; 3 ft. 6 in.; 95 lb. G.; max. grad., 1 in 11; min. radius, 35 ft.; span wires and centre and side poles; swivel trolley; contrs. overhead equip., R. W. Blackwell & Co., and B.I.W.; feeders, Henley's; 6 d. deck and 6 s. deck bogie truck cars; car bodies, Brush Co.; trucks, Brill; motors, B.T-H. 28 h.p., G.E. 58. Current from own station at a cost of 1½d. per unit; generators, 3 Greenwood & Batley; engines, 3 vert. cross comp. corliss, Combe, Barbour & Co.; boilers, 2 B. & W.; total, 300 kw. [2-5]

Portsmouth Corporation Tramways, Town Hall, Portsmouth. *Gen. Manager*, W. R. Spaven; *Elec. and Per. Way Eng.*, V. G. Lironi; *Traffic Supt.*, W. Munford; *Chairman Try. Com.*, H. Kimber; *Vice-Chairman*, Ald. J. H. Corke.
E Sept., 1901; 14·5 mi. route; 28·5 mi. track; S.G.; 96 lb. G.; max. grad., 1 in 17; min. radius, 35 ft.; centre and side poles, span wire and brackets; 00 wire; fixed trolley; contrs. for overhead equip., Macartney, McElroy & Co.; feeders, B.I.W., paper insulated; 81 d. deck 4-wheel cars; car bodies, Dick, Kerr & Co.; motors, Dick, Kerr & Co. 25 h.p. 25 A.; trucks, Brill 21 E.; generators, 4 Dick, Kerr & Co.; engines, 3 slow speed hor. Corliss, Yates & Thom, 1 Belliss & Morcom; boilers, 3 B. & W.; 1,100 kw. [2-5]

Preston Corporation Tramways, Holmrook Road, Preston, Lancs. *Manager and Elec. Eng.*, W. H. Tittensor; *Traffic Supt.*, E Lafferty; *Chairman Try. Com.*, Coun. E. J. Andrew; *Vice-Chairman*, Coun. S. Crompton.
E June, 1904; 10 mi. route; 16·3 mi. track; S.G; 95 lb. G.; max. grad., 1 in 16; min. radius, 42; span wire and side-bracket arms; 00 wire; swivel trolley; sub-contrs. overhead equip., Blackwell & Co.; feeders, St. Helens Cable Co.; 30 d. deck 4 bogie and 26 4-wheel truck cars; car bodies, Dick Kerr & Co.; trucks, Brill 21 E.; motors, 25 and 30 h.p. Dick Kerr & Co.; current supply from own station works, cost ·416d. per unit; generators, 2 multipolar, Dick, Kerr; engines, 2 hor. cross. comp. Cole, Marchent & Morley; boilers, 2 Lancs., Yates & Thom; total, 600 kw. [2-5]

Radcliffe Urban District Council Tramways, Council Offices, Radcliffe, Lancs. *Gen. Manager*, W. Clough; *Elec. Eng.*, M. B. Henry; *Per. Way Eng.*, W. L. Rothwell; *Chairman Try. Com.*, J. H. Lund; *Vice-Chairman*, W. Allan, Junr.
E April, 1905; 5 mi. route; 6·5 mi. track; S.G.; 100 lb. G.; max. grad., 1 in 15; min. radius, 40 ft.; 3 wire; contrs. overhead equip., Macartney, McElroy & Co.; feeders, Callenders, paper insulated, lead covered; Current supplied from own stations at 1½d. per unit; generators, 2 multipolar, Mather & Platt; engines, 2 vert. Comp. 200 h.p., Browett, Lindley & Co.; boilers, E. Heaton & Son, 2 Lanc. 30 ft. by 7½ ft.; total, 240 kw. [3-5]

Reading Corporation Tramways, Mill Lane, Reading. *Gen. Manager and Elec. Eng.*, W. Binns; *Chairman Try. Com.*, Coun. A. H. Bull.
E July, 1903; 7·25 mi. route; 13·25 mi. track; 4 ft.; 96 lb. G; max. grad., 1 in 16; min. radius, 40 ft.; centre pole, side brackets; 0000 wire; swivel trolley; contrs. overhead equip., Blackwell & Co.; feeders, Henleys and B.I.W.; 36 d. deck cars (6 bogie and 30 4-wheel trucks), and 1 water car; car bodies, Dick, Kerr and Co.; motors, Dick, Kerr & Co., 25 and 35 h.p. 25 A.; trucks, Brill, 21 E.; generators, 4 multipolar D-C, Westinghouse; engines, Browett-Lindley, 4, vertical, enclosed; boilers, B. & W. 3 multitubular, with superheaters; 400 kw. [2-5]

Rochdale Corporation Tramways, Mellor Street, Rochdale. *Gen. Manager*, J. S. D. Moffet; *Traffic Manager*, G. Webster; *Elec. Eng.*, C. C. Atchison (*Boro' Elec. Eng.*); *Per. Way Eng.*, S. S. Platt (*Boro' Surveyor*). *Chairman Try. Com.*, Coun. W. Dunning.
E May, 1902; 13·5 mi. route; 19·7 mi. track; S.G.; 103·5 lb. G.; max. grad., 1 in 11·7; min. radius, 30 ft.; span and bracket arm; 000 wire; swivel trolley; contrs. overhead equip., Macartney, McElroy & Co., and J. G. White & Co.; feeders, Glover & Co., lead covered; 34 d. deck and 15 s. deck cars (25 bogie and 24 4-wheel); car bodies, Milnes & Co., Dick, Kerr & Co., and Brush; motors, B.T-H., Brush, and Dick, Kerr & Co., 25 and 35 h.p. (1 car with 4 motors); trucks, Brill and Brush. Current taken from Corporation Elec. Works at from 1·5d., over 700,000 1d. per unit; generators, 2 Siemens', 2 Johnson-Lundell, 1 E.C.C., and 2 B.T-H.; engines, 5 Belliss & Morcom, 2 Browett-Lindley high speed enclosed; boilers, 5 Lancashire, 3 Yates & Thom, 2 Oldham Boiler Works; 2,196 kw. [2-5]

Rotherham Corporation Tramways. Rawmarsh Road, Rotherham. *General Manager*, W. Grant; *Elec. Eng.*, E. Cross; *Chairman Try. Com.*, Ald. D. L. Winter; *Vice-Chairman*, Coun. T. Reeves.
E January, 1903; 7·75 mi. route; 9·33 mi. track; S.G.; 88·5 lb. G.; max. grad. 1 in 10·5; min. radius, 45 ft.; bracket arm and span wire; 0 wire; swivel trolley; contrs. overhead equip., Macartney, McElroy & Co.; feeders, Glover single lead, solid; 27 d. deck and 3 s. deck cars, total, 30 4-wheel cars; car bodies, Dick, Kerr & Co.; motors, Dick, Kerr & Co., 25 h.p., type 25 A; trucks, Brill 21 E. Current taken from Corp. elec. works at 1½d. per unit; generators, 1 320 kw. Siemens and 7 Allen's; engines, 8 Allen's, H.S. Comp.; boilers, 7, Lancs., Tetlows' and Hoxley Wild; total, 900 kw. [2-5

Salford Corporation Tramways, 32, Blackfriars Street, Salford. *Gen. Manager and Engineer*, Geo. W. Holford; *Elec. Eng.*, C. D. Taite; *Chief Assist.*, G. W. Holford; *Traffic Supt.*, C. H. Chester; *Chairman Try. Com.*, Ald. H. Linsley; *Vice-Chairman*, Coun. J. Barnes.
E Oct., 1901; 30 mi. route; 59·5 mi. track; S.G.; 103 lb. G.; max. grad., 1 in 20; min. radius, 45 ft.; span wire, centre and side poles; 0·4 wire; swivel trolley; contrs. for overhead equip., Geo. Hill & Co.; feeders, W. T. Glover & Co.; 150 d. deck (100 4-wheel and 50 bogie) cars; car bodies, Milnes & Co. & Brit. Elec. Car Co.; motors, Westinghouse, 25 and 36 h.p., 4 25 h.p. on the bogie truck cars; trucks, Brill 21 E. & 27 G. Current taken from Corporation elec. works at 1½d. per unit (less 2½ per cent.); generators, 8 Mather & Platt; engines, 8, D-C, Browett-Lindley; boilers, 16, Lancs., Galloways; 6,400 kw. [2-5]

Sheffield Corporation Tramways, Division Street, Sheffield. *General Manager*, A. R. Fearnley; *Elec. Eng.*, H. E. Yerbury; *Traffic Supt.*, A. Handford; *Per. Way. Eng.*, C. F. Wike (City Surveyor); *Chairman Try. Com.*, Ald. W. E. Clegg; *Vice-Chairman*, Coun. W. C. Fenton.
E Sept., 1899; 35·75 mi. route; 65·75 mi. track; S.G.; 108·5 lb. G.; max. grad., 1 in 9·5; min. radius, 36 ft.; centre and side poles; 0 wire; swivel trolley; contrs. overhead equip., B.T.-H.; feeders, Callender's, St. Helens, Glover & Co., and B.I.W.; 181 d. and 69 s. deck cars (total, 250 with 4-wheel trucks, 66 with top covers); car bodies, Brush, Milnes, Cravens, Ltd., Elec. Try. & Ry. Car. Works; motors, B.T-H. (GE. 52 27 h.p. and G.E. 58 32 h.p.); trucks, Peckham, Milnes, Brush, and Brill. Current from tramway station at ·61d. per unit; generators, 7 B.T-H.; engines, 3 Allis hor. and 4 Cole, Marchent, & Morley vert.; boilers, 6 Brown's Marine, 3 Stirling, 2 Davy Dry Back Marine; 3,675 kw. [4-5]

Shipley Urban District Tramway, Dockfield, Shipley. *Elec. Eng.*, S. D. Schofield; *Chairman Try. Com.*, Miles Rhodes.
E May, 1902; 6 mi. route; 10 mi. track; 4 ft.; 90 lb. G.; max. grad., 1 in 15; span wires; 000 wire; contrs. overhead equip., Lowdon Bros. and J. G. White & Co.; feeders, Glovers. These lines are leased to Bradford Corporation and are worked as a part of Bradford tramways. Current is supplied to the Shipley section by Shipley elec. works at 1·75d. per unit. The station contains 3 240 and 1 400 k.w. Parson's steam turbines supplying current for both tramways and lighting; total, 1,120 kw.; boilers, 4 Holsworth and Clayton and Co.; 4·5 mi. route, in addition to the above, are now under cons., and this section is leased to the Mid-Yorkshire Trys. Co., who are carrying on the construction of these lines. [2-5]

(*Continued on page xlic.*)

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LAYING CALLENDER MAINS ON SOLID SYSTEM AT BOMBAY.

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ELECTRIC TRAMWAY AND RAILWAY DIRECTORY—*continued.*

(For Tramway Companies *vide* page xlvi.)

Southampton Corporation Tramways, 184, Above Bar Street, Southampton. *Gen. Manager and Boro.' Elec. Engineer*, H. F. Street; *Traffic Manager*, C. George Simpson; *Per. Way Eng.*, J. A. Crowther; *Chairman Try. Com.*, Ald. F. A. Dunsford; *Vice-Chairman*, Coun. J. Hollis.

E Jan., 1900; 9·5 mi. route; 16·5 mi. track; S.G.: 86 lb. G.; max. grad., 1 in 11; min. curve, 35 ft.; side and centre poles; 00 wire; swivel trolley; contrs. overhead equip., Macartney, McElroy, & Co. and Blackwell & Co.; feeders, Glover & Callender's; 49 d. deck 4-wheel cars; car bodies, Milnes and Hurst, Nelson & Co., motors, Westinghouse 25 h.p.; trucks, Brill. Current taken from Corp. Elec. Works at 2d. per unit; generators, 2 Dick, Kerr, 2 British Schuckert, 3 Crompton & Co.; engines, Pollett & Wigzell, 7 slow speed horizontal; boilers, 2 Lancashire and 5 B. & W. water-tube; 1,300 kw. [4-5]

Southend-on-Sea Corporation Tramways, London Road, Southend-on-Sea. *Gen. Manager and Elec. Eng.*, ; *Asst. Eng.*, W. A. Dyer; *Chairman Try. Com.*, R. Roberts.

E July. 1901; 6·36 mi. route; 7·5 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad., 1 in 18; min. radius, 48; side poles; ·4 wire; swivel trolley; contrs. for overhead equip., Dutilh, Smith, McMillan & Co.; feeders, Callender's solid; 20 d. and 2 s. deck cars (10 bogie and 12 4-wheel truck cars); car bodies, Brush and Milnes; motors, B.T-H. Co., Brush and Westinghouse 20 h.p.; trucks, Brill and Brush; Current taken from Corp. elec. works at 1¼d. per unit; generators, 2 Bow, Maclachan, 2 Crompton, 1 Bruce-Peebles; engines, 3 Willans, 2 Bow, Maclachan; boilers, 3 Economic and 2 B. & W.; total, 1,125 kw. (400 kw. for traction). [2-5]

Southend Pier Electric Railway, (owned by Southend-on-Sea Corporation), Southend-on-Sea. *Manager*, Capt. F. E. Kemps; *Elec. Eng.*, C. R. Norton. *Per. Way Eng.*, E. J. Elford; *Chairman*, Ald. Prevost.

E Aug. 1890; 1·25 mi. route; 1·25 mi. track; 3 ft. 6 in.; 60 lb. G.; third rail (Crompton & Co., contractors); 14 s. deck open cars, and two closed motors cars; car bodies, Brush; motors, B.T-H. Co.; trucks, Brush. Current taken from Corporation Elec. Works at 2d. unit. [2-5]

Southport Corporation Tramway, 44, Chapel Street, Southport. *Gen. Manager*, T. J. Kendrew; *Boro' Elec. Eng.*, R. S. Downe; *Per. Way Eng.*, C. Minns; *Chairman*, Ald. Hulme; *Vice-Chairman*, Coun. J. Boyd.

E July, 1900; 8·5 mi. route; 10·75 mi. track (also 8·9 mi. leased to Southport Trys. Co.); S.G.; 87 lb. & 90 lb. G.; max. grad., 1 in 25; min. radius, 45 ft; bracket arm; 0 and 00 wire; swivel trolley; contrs. for overhead equip., Macartney, McElroy & Co.; feeders, Callenders (solid); 17 d. deck cars and 9 s. deck cars (total, 26 4-wheel); car bodies, Elec. Try. & Ry. Car Works; motors, Dick, Kerr & Co. (25 h.p., type A); trucks, Brill (21 E). Current taken from the Corp. Elec. Works at 1·5d per unit; generators, 3 Bruce, Peebles, & Co. 4-pole; engines, 3 Belliss, vertical; boilers, 9 Lancs., Musgrave, Heaton & Co., and Oldham Boiler Co.; 600 kw. [2-5]

South Shields Corporation Tramways, Court Buildings, South Shields. *Elec. Eng.*, J. H. Cawthra; *Boro'. Eng.*, S. E. Burgess; *Chairman Try. Com.*, Coun. Jas. Grant; *Vice-Chairman*, Coun. W. G. Wylie.

E Under con.; cars, Hurst, Nelson, & Co. [4-5]

Stalybridge, Hyde, Mossley, and Dukinfield Tramways & Electricity Board, Town Hall, Stalybridge. *Commercial Manager*, F. Schofield; *Resident Eng.*, R. Blackmore; *Chairman Try. Com.*, T. C. Beeley *Vice-Chairman*, J. Ridyard.

E May, 1904; 23·5 mi. route; 30·75 mi. track; S.G.; 99 lb. G.; max. grad., 1 in 10; min. radius, 35 ft.; span wire and side brackets; 000 wire; swivel trolley; contrs. for overhead equip., Dick, Kerr & Co.; feeders, Glovers (lead covered); 20 d. deck and 20 s. deck 4-wheel cars; car bodies, British Elec. Car Co.; motors, Westinghouse 25 h.p.; trucks, McGuire Mfg. Co. Current from own station at a cost of 1½d. per unit. Generators, 3 three-phase, Dick, Kerr & Co.; engines, 3 Marine-enclosed, Yates & Thom, each 750 h.p.; boilers, 6 Lancs., Tinker & Shenton; total 1,500 kw. [6-4]

Stockport Corporation Tramways, 1, Brown Street, Stockport. *Manager*, A. T. Eardley; *Elec. Eng.*, A. J. H. Carter; *Per. Way Eng.*, J. Atkinson; *Chairman Try. Com.*, Coun. Chas. Sharples; *Vice-Chairman*, Coun. Jas. Fernley.

E Aug., 1902; 10·36 mi. route; 17 mi. track; S.G.; 96 lb. G.; max. grad., 1 in 10; min. radius, 40 ft.; span wire, centre and side pole; ·4 wire; swivel trolley; contrs. for overhead equip., B.I.W. Co.; feeders, Glover's; 30 d. deck 4-wheel cars (also 1 water car); car bodies, Dick, Kerr & Co.; motors, Dick, Kerr & Co., 35 h.p.; trucks, Brill. Current taken from Corp. elec. works, price 1·25d. per unit; generators, 3 Parson's steam turbine; engines, 3 Parson; boilers, B. & W. [4-5]

Sunderland Corporation Tramways, Tramway Offices, Sunderland. *Gen. Manager*, A. R. Dayson; *Boro'. Elec. Eng.*, J. F. C. Snell; *Chairman Try. Com.*, Coun. T. Summerbell.

E June, 1900; 10·87 mi. route; 19·54 mi. track; 4 ft. 6 in.; 96 lb. G.; max. grad., 1 in 14; min. radius, 35 ft.; flexible suspension; 0 wire; swivel trolley; contrs. for overhead equip., Dick, Kerr & Co. and Siemen Bros.; feeders, Callender's; 51 d. deck and 13 s. deck cars (total 64 4-wheel cars); car bodies, Elec. Try. & Ry. Car. Works; motors, Dick, Kerr & Co., 25 h.p. (25 A); trucks, Brill (21 E.) Current taken from Corp. elec. works at 1½d. per unit; generators, 4 multipolar, Sunderland Forge Co.; engines, 4 Belliss; boilers, 4, Lancs. Galloways; 1,100 kw. [2-5]

Swindon Corporation Tramways, Electricity Works, Swindon. *Gen. Manager and Elec. Eng.*, J. G. Griffin; *Traffic Manager*, T. Medcalf; *Consulting Engs.*, Lacey, Clirehugh, & Sillar; *Chairman Try. Com.*, Coun. A. W. Deacon; *Vice-Chairman*, Coun. J. T. Smith.

E Sept., 1904; 3·7 mi. route; 4·14 mi. track; 3 ft. 6 in.; 105 lb. G.; max. grad., 1 in 14; min. radius, 37 ft.; bracket arm; 00 wire; swivel trolley; contrs. overhead equip., J. G. White & Co.; feeders, B. I. & H. Cables, Ltd.; 9 d deck 4-wheel cars; car bodies, Dick, Kerr, & Co.; motors, Dick-Kerr, 37 h.p.; trucks, Brill, 21 E. Power to be supplied by the Corp. Elec. Dept. at 2d. per unit.; generators, 3 Siemen Bros.; engines, 3 Browett-Lindley, triple expansion; boilers, 3 Lancs., Tinker Shenton & Co.; total, 200 kw. [2-5]

Wallasey Urban District Council Tramways, Sea View Road, Liscard, Cheshire. *General Manager*, R. R. Greene; *Elec. Eng.*, J. A. Crowther; *Per. Way Eng.*, W. H. Travers; *Chairman Try. Com.*, J. Braithwaite; *Vice-Chairman*, Dr. T. W. A. Napier.

E March, 1902; 8·5 mi. route; 11·85 mi. track; S.G.; 98 lb. G.; max. grad., 1 in 14; min. radius, 45 ft.; side pole and span wire; 000 wire; swivel trolley; contrs. for overhead equip., Blackwell & Co.; feeders, B.I.W. Co.; 30 d. deck 4-wheel cars (19 with top covers); car bodies, Dick, Kerr & Co.; motors, Dick, Kerr & Co. 25 h.p. (type A.); trucks, Brill 21 E. Current taken from Council elec. works at 1½d. per unit; generators, 3 Lancashire Dynamo Co., 2,050 kw. compound-wound; engines, 2 Galloways, 1 Browett-Lindley & Co., vertical; boilers, 5 Lancs., 1 water-tube, B. & W.; 1,100 kw. [2-5]

Walsall Corporation Tramway, Bescrihills Depot, Bloxwich Road, Walsall. *Gen. Manager*, R. L. Horsfield; *Elec. Eng.*, Alex. Wyllie; *Per. Way Eng.*, R. H. Middleton; *Chairman*, Coun. J. Cope; *Vice-Chairman*, Coun. J. Williams.

E Jan., 1904; 12 mi. route; 16 mi. track; 3 ft. 6 in.; 92 lb. G.; max. grad., 1 in 18; min. radius, 56 ft.; side brackets, flexible suspension; 0 wire; swivel trolley; contrs. overhead equip., Blackwell & Co.; feeders, Callenders; 28 d. deck 4-wheel cars (6 with top covers); car bodies, Brush; motors, B.T-H., 30 h.p.; trucks, Brush. Current from Corp. Elec. Dept. at 1½d. per unit; generators, 5 2-pole and 2 4-pole, Thos. Parkers, Ltd., D.-C.; engines, 7 high speed, Bumsted and Chandler; boilers, 2 Lancs., H. & T. Danks, 3 water-tube, B. & W.; Belliss and Morcom condenser; total, 950 kw. [2-5]

Walthamstow and District Light (Electric) Railway, Priory Avenue, Walthamstow. *Elec. Eng. and Manager*, T. H. Fooks-Bale; *Traffic Supt.*, F. Armstrong; *Per. Way Eng.*, G. W. Holmes; *Chairman Trys. Com.*, R. G. Woolley; *Vice-Chairman*, J. Anderson.

E June, 1905; 9 mi. route; 9·75 mi. track; S.G.; 100 lb. G.; max. grad., 1 in 20; min. radius, 40 ft.; side poles and span wire; ·364 wire; swivel trolley; contrs. track and overhead equip., W. T. Henley's and Dick, Kerr & Co.; cables, W. T. Henley; 32 d. deck 4-wheel cars; car bodies, Brush; motors, Westinghouse 30 h.p.; trucks, Brush Co. Current from own power-station; generators, Suter & Co. (Helios), 4 375 kw.; engines, 4 Westinghouse gas engines; boilers, 4 small for gas generators, Down Gas Plant; 1,500 kw. [2-5]

Warrington Corporation Tramways, Mersey Street, Warrington. *Manager*, J. Telfer; *Elec. Eng.*, F. V. L. Mathias; *Per. Way Eng.*, T. Longden. *Chairmen Try. Com.*, Ald. Smethurst; *Vice-Chairman*, Coun. Wilkinson.

E April, 1902; 6 mi. route; 8·5 mi. track; S.G.; 90 lb. G.; max. grad., 1 in 27; min. radius, 50 ft.; span wire, side and centre poles; 0000 wire; swivel trolley; contrs. overhead equip., Blackwell & Co.; feeders, St. Helen's Cable Co.; 21 d. deck 4-wheel cars; car bodies, Milnes; motors, B.T-H. Co., 19 h.p.; trucks, Brill and Brush. Current taken from Corp. elec. works, at 2d. per unit (after 100,000 units 1½d. per unit); generators. Bruce-Peebles 1 100 kw. and 2 250 kw., 1 500 kw. Dick-Kerr, and 1 750 kw. Siemens'; engines, 5 Willans & Robinson; boilers, 7 Water-tube, B. & W.; 250 kw. [2-5]

West Bromwich Corporation Tramway, Electricity Works, West Bromwich. *Borough Eng.*, A. D. Greatorex; *Resident Eng.*, J. H. Wray; *Chairman Try. Com.*, Ald. Pitt; *Vice-Chairman*, Coun. W. Lawley.

E Dec., 1902; 9 mi. route; 18·5 mi. track; 3 ft. 6 in.; 98 lb. G.; max. grad., 1 in 17; min. radius, 50 ft.; span wires, side and centre poles; 000 wire; swivel trolley; contrs. overhead equip., B.I.W. Co.; feeders, B.I.W. Co.; 25 d. deck bogie truck cars; car bodies, Brush; motors, Brush Co., 27 h.p.; trucks, Brush Co. The tramways are leased to the So. Staff. Trys. Co., and current for this section of that company's lines is supplied by West Bromwich Corp. elec. works at 2d. for first 400,000 units, 1½d. per unit afterwards. Generators, 8 Parsons turbines; 7 Parsons turbines; boilers, 2 Danks and 4 B. & W. [2-5]

West Ham Corporation Tramways, West Ham Lane, West Ham. *Tramways Manager*, H. E. Blain; *Boro' Elec. Eng.*, W. J. W. Bullock; *Chairman Try. Com.*, Ald. W. Ivey.

E February, 1904; 9·75 mi. route; 17 mi. track; S.G.; 100 lb. G.; max. grad., 1 in 20; min. radius, 40 ft.; side pole, flexible suspension; 0000 wire; swivel trolley; contrs. overhead equip., Blackwell & Co. and Macartney, McElroy & Co.; feeders, B-I.W. (lead covered); 50 d. deck 4-wheel cars; car bodies, Milnes & Co.; motors, Witting, Eborall & Co., 25 h.p. 500 v; trucks, Brush. Current obtained from Corp. elec. works at 1·6d. per unit; generators, 500 kw. Bruce-Peebles, 3 comp. multipolar; engines, 3 500 kw., vertical, cross comp. Ferranti; boilers, 17 water-tube, B. & W.; total 1,500 kw. [2-5]

Wigan Corporation Tramways, Bradford Place, Wigan. *Manager and Elec. Eng.*, James Slevin; *Per. Way Eng.*, W. Bolton; *Chairman Try. Com.*, Ald. R. Johnson; *Vice-chairman*, Coun. Wm. Lowe.

E April, 1901; 25 mi. route; 35 mi. track; 3 ft. 6 in. and S.G.; 100 lb. G.; max. grad., 1 in 12 min. curve, 45 ft.; bracket arm suspension; 000 and 0000 wire; swivel trolley; contrs. for overhead equip., R. W. Blackwell & Co. and J. G. White & Co.; feeders, Glover & Co. and Johnson & Phillips; 13 d. deck 4-wheel and 54 s. deck bogie truck cars; car bodies, Dick, Kerr & Co. and Hurst, Nelson, & Co.; motors, Dick, Kerr & Co. and Westinghouse, 25 h.p. and 35 h.p.; trucks, Brill, Hurst, Nelson, & Co. Current taken from Corp. elec. works at 1·5d. per unit; generators, 6 General Electric Co. and Dick, Kerr; engines, 7 Willans & Robinson; boilers, 6, B. & W.; 1023 kw. [4-5]

Wolverhampton Corporation Tramways, Car Depot, Cleveland Road Wolverhampton. *Manager*, W. A. Luntley; *Elec. Eng.*, C. E. C. Shawfield; *Per. Way Eng.*, George Green; *Chairman Try. Com.*, Ald. C. T. Mander; *Vice-Chairman*, Ald. S. Craddock.

E April, 1902; 12 mi. route; 20 mi. track; 3 ft. 6 in.; 96 lb. G.; max. grad., 1 in 17; Lorain surface contact system; contrs., Lorain Steel Co.; feeders, Callender's; 28 d. deck and 12 s. deck cars (total, 40 4-wheel); car bodies, Dick, Kerr & Co., and Milnes; motors, Lorain, Westinghouse, and B.T-H., Dick, Kerr, 25 h.p.; trucks, Lorain and Brill. Current taken from Corp. elec. works at 1½d. per unit; generators, 3 E.C.C. and 2 Parker's; engines, 2 Willans, 2 Belliss, 1 Davy Paxman; boilers, 6 Lancs. and 2 Economic; 1,940 kw. [2-5]

Continued on page xlvi.

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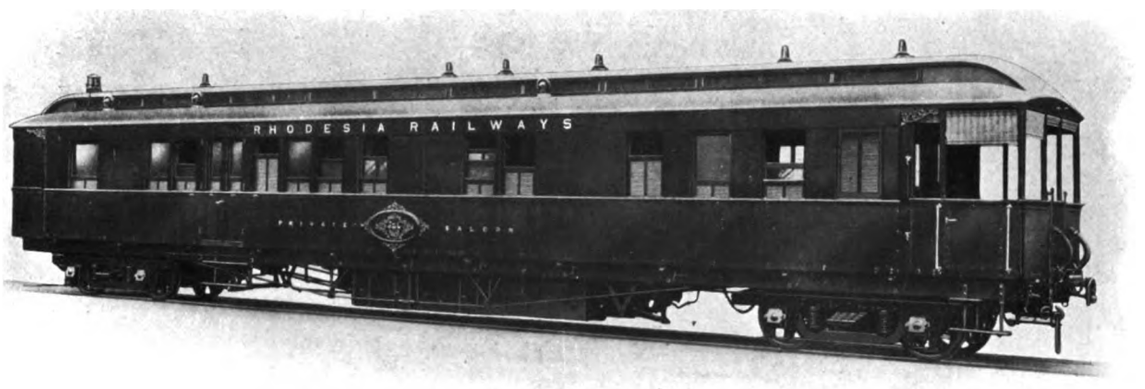

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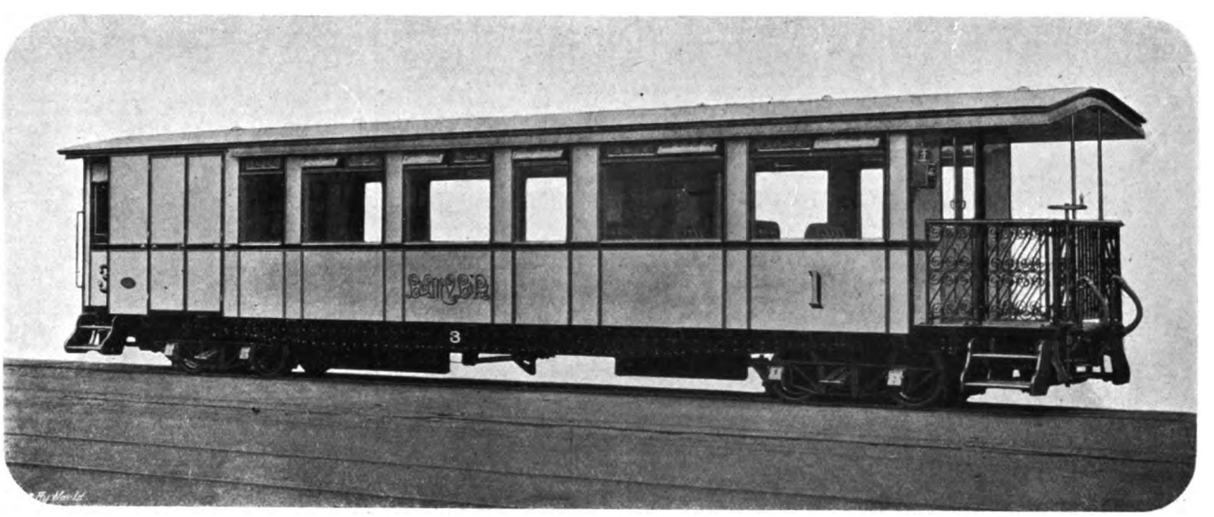

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TRAMWAY COMPANIES.

Aberdeen Suburban Tramways Company, 15, Golden Square, Aberdeen. *Managing Director*, A. Wilkie; *Traffic Inspector*, W. Kerr; *Elec. Eng.*, T. Ross; *Per. Way Eng.*, J. G. Jenkins; *Sec.*, G. Duncan; *Chairman*, G. J. Walker; *Directors*, W. Jackson, J. Morgan, Dr. Christie, Treasurer Wilkie.
E June, 1904; 5 mi. route; 5 mi. track; S.G.; 95 lb. G.; side poles; fixed trolley; contrs. overhead equip., G. J. White & Co.; 6 d. deck 4-wheel cars; car bodies, Brush Co.; motors, B.T-H.; trucks, Brush Co. Current from Aberdeen Corporation at 2¼d. per unit. [10-4]

Airdrie and Coatbridge Tramways Company, Tramway Depôt, Main Street, Coatbridge, and Donington House, Norfolk Street, London, W.C. *Gen. Manager*, A. Delves; *Sec.*, E. Hopwood; *Chairman*, Viscount Emlyn; *Directors*, F. B. Lea (Managing), H. S. Day, A. C. Miles.
E Feb., 1904; 8·5 mi. route; 4·75 mi. track; S.G.; 94 lb. G.; max. grad. 1 in 14; min. radius, 220 ft.; span wire and bracket arm; 0 wire; swivel trolley; contrs. overhead equip., Brush Elec. Eng. Co.; feeders, B.-I. W. and Western Elec. Co.; 12 d. deck 4-wheel cars; car bodies, Brush; motors, Brush, 1,000 B.; trucks, Brush; Current obtained from the Scottish House to House Elec. Supply Co. [4-5]

Barnsley and District Electric Traction Company, Tramway Depot, Barnsley. *Manager and Eng.*, W. H. Moorhouse; *Sec.*, C. H. Godward; *Chairman*, Lieut. Col. Sir Thomas Pilkington, Bart.; *Directors*, W. J. Greer, E. A. Paris.
E Nov., 1902; 3·06 mi. route; 4·24 mi. track; S.G.; 94 lb. G.; max. grad., 1 in 10; min. radius, 66 ft.; span wire, centre under running trolley; 0 wire; swivel trolley; contrs. overhead equip., J. G. White & Co.; feeders, Western Electric Co. and W. T. Henley's; 12 d. deck 4-wheel cars; 31 h.p. Brush (1000 B) motors; Brush car bodies and trucks; current from Barnsley Corporation Electricity Works at 1½d. per unit; generators, 6, Johnson Phillips, Willans, and Peebles, D-C.; engines 6, Willans; boilers, 5 Lancs.; total 300 kw. [4-5]

Barrow-in-Furness Tramways, Salthouse Road Depot, Barrow, and Donington House, Norfolk Street, W.C. *Manager*, W. F. Bladon; *Sec.*, S. N. Wells; *Chairman*, S. A. Sillem; *Directors*, H. S. Day, F. B. Lea, J. V. Kitchener.
E Feb. 1904; 5·37 mi. route; 7·75 mi. track; 4 ft. 94 lb. G.; max. grad., 1 in 14; min. radius, 50 ft.; span and centre pole; 0 wire; swivel trolley; contrs. overhead equip., Brush Co.; feeders, B-I.W., paper and lead covered; 7 d. deck and 5 s. deck cars (5 with bogie and 7 with 4-wheel trucks), and 2 demi cars; car bodies, Brush and British Elec. Car Co.; motors, Dick, Kerr & Co. and B. E. C. Co., A. 25 h.p.; trucks, Brush and B. E. C. Co., max. standard. Current to be taken from Corp. elec. works at 2d. per unit. [4-5]

Bath Electric Tramways, Walcot Street, Bath, and 18, St. Helen's Place, London, E.C. *Manager and Elec. Eng.*, R. D. McCarter, Jr.; *Traffic Supt.*, E. Seckington; *Res. Engineer*, W. E. Hardy; *Engs.*, Harper Bros. & Co., and George Hopkins & Son; *Sec.*, H. J. Almond; *Chairman*, Sir Vincent Caillard; *Directors*, Hon. Sir J. Sivewright, H. F. Clutterbuck, H. A. Butters, A. A. C. Swinton.
E Jan., 1901; 12·5 mi. route; 16 mi. track; S.G.; 95 lb. G.; max. grad., 1 in 10·6; min. radius, 37·5 ft.; span wire and side pole; 00 wire; swivel trolley; contrs. for overhead equip., Chas. Chadwell & Co.; feeders, B.I.W.; 34 d. and 6 s. deck 4 wheel cars; car bodies, Milnes & Co.; motors, Westinghouse 30 h.p. (49 B.); trucks, Milnes & Co.; generators, 4 D-C. Westinghouse; engines, Yates & Thom, 3 horizontal, and 1 Westinghouse; boilers, 3 B. & W. (total 675 kw.) [9-4]

Bessbrook and Newry Tramway Company, Bessbrook. *Manager*, Robert Caven; *Elec. Eng.*, J. L. D. Meares; *Secretary*, W. Scott.
E Aug. 1901; 3 mi. route; 3 mi. track, 3 ft.; 41 lb. Vig.; max. grad., 1 in 80; min. radius, 55 ft.; third rail; two motor cars (also 27 trail cars); motors, Mather & Platt; car bodies, Milnes & Co.; trucks, Milnes & Co.; water power; turbines of 26 kw. capacity.

City of Birmingham Tramways Company, Ltd. (SECTION OF BIRMINGHAM AND MIDLAND JOINT COMMITTEE TRAMWAYS). Central House, 75, New Street, Birmingham. *Engineering Manager*, G. Conaty; *Traffic Manager*, A. W. Cramp; *Superintendent*, F. H. Barling; *Secretary*, Chas. W. Patrick; *Directors*, E. Garcke (*Chairman*), J. A. Christie, G. C. Cuningham, C. S. B. Hilton, W. Neale, J. A. Lycett (*Managing*).
E May, 1901; *16 mi. route; *24 mi. track; 3 ft. 5 in.; 97 lb. G.; max. grad., 1 in 16; min. radius, 40 ft.; side pole, rigid and flexible; 00 wire; swivel trolley; contrs. overhead equip., R. W. Blackwell & Co.; feeders, Callender's solid system; 56 d. deck cars, 11 bogie and 45 4-wheel; car bodies, Dick, Kerr & Co. and Brush Elec. Eng. Co.; motors, British T-H. and Brush, 25 h.p.; trucks, Peckham, Brush, and Radial. Current from Own Power Station; generators, 2 General Electric 8-pole 2-100 kw. and 1-225 kw. Brush; engines, 2 Pennsylvania Iron Works, U.S.A., hor. cross comp. 1 Belliss vert., 2 Diesel, fuel oil; boilers, 1 Galloways and 2 Adamson; total 875 kw.

* This length includes also 4 miles track; span construction; 0000 wires; swivel trolley; own power-station, 4 100 kw. Diesel-Brush plants. [4-5]

Birmingham and Midland Tramways, Ltd., Central House, Birmingham, and Donington House, Norfolk Street, London, W.C. *Engineering Manager*, G. Conaty; *Traffic Manager*, R. W. Cramp; *Secretary*, B. Kingsford; *Directors*, C. Shirreff Hilton (chairman), J. A. Lycett, Sir E. Spencer, S. R. Blundstone.
E July, 1904; 11·125 mi. route; 12·875 mi. track; 3 ft. 6 in.; 85 & 94 lb. G.; max. grad., 1 in 15; min. radius, 31 ft.; span and side bracket; 0 and 00 wire; swivel trolley; contrs. overhead equip., Brush Co.; feeders, B.I.W. and Callender's; 40 d. deck and 3 s. deck 4-wheel cars; car bodies, Brush Co.; motors, Brush 1,002 B and 1,002 D 32 h.p.; trucks, Brush, and Lycett & Conaty, and Peckham; current from Smethwick generating station; generators, 3 300 kw. Brush Co., and 3 500 kw. B.T.H. 3-phase 5,500 volts; engines, Brush, 3 comp., and 3 triple expansion; boilers, 5 B. & W.; total, 2,400 kw. [4-5]

Blackpool and Fleetwood Tramroad Company, Ltd., Bispham, near Blackpool. *General Manager and Secretary*, J. Cameron; *Elec. Eng.*, A. Cameron; *Chairman*, George Richardson; *Directors*, R. H. Prestwich, R. B. Barningham, R. S. Boddington, J. Greenwood, Geo. Readman.
E July, 1898; 9 mi. route; 15·19 mi. track; S.G.; 81 lb. G. and 56 V.; max. grad., 1 in 26; min. radius, 80 ft.; side and centre pole; 000 wire; fixed trolley; contrs. for overhead equip., Mather and Platt; feeders, Callender's and B.I.W.; 31 s. deck bogie cars; car bodies, Milnes & Co. and Dick, Kerr & Co.; motors, Dick, Kerr & Co., 44 S. 1,000, and B.T-H. GE. 1,000 35 h.p.; trucks, Brill and Milnes; current obtained from own station at a cost of ·93d. per unit; generators, 5, Mather & Platt, shunt, 120 kw.; engines, Mather & Platt, 5 D-C. Marine; boilers, 3 Galloways, 1 Adamson, and 1 Green's economiser; (total 600 kw.). [4-5]

Blackpool and Fylde Light Railway Company, 5, Clifton Street, Blackpool. *Engineer*, J. J. Myres; *Chairman*, John Greenwood; *Directors*, T. Fisher, J.P., Chas. Hopkinson, John Platt, Wm. Walker, H. P. May.
E Under cons.; 14 mi. route; 14·5 mi track; S.G. [11-4]

Blackpool, St. Anne's, and Lytham Tramways Company, Ltd., 30, Birley Street, and 300, Lytham Road, Blackpool. *Gen. Manager*, ; *Per. Way Engineer*, W. Marshall; *Sec.*, Chas. E. Riding; *Chairman*, Thos. Blane; *Directors*, M. Guthrie, Brabley, T. W. Smith.
E May, 1903; 7·5 mi. route; 13·7 mi. track; S.G.; 92 lb. G.; max. grad., 1 in 28; min. radius, 45 ft.; span wire and side poles; 000 wire; swivel trolley; contrs. overhead equip., Chas. Chadwell; feeders, Anchor Cable Co., paper covered; 30 d. deck 4-wheel cars; car bodies, British Elec. Car Co.; motors, B.T-H. (GE. 52); trucks, British Elec. Car Co., standard. Current obtained from Local Authorities at 2d. per unit. [9-4]

Bray and Enniskerry Railway Company, 52, Westland Row, Dublin. *Sec.*, M. F. Keogh; *Chairman*, A. Killingley, F. M'Crea.
E (under cons.); 3·25 mi. route; 5 mi. track; 3 ft. 6 in.

Brighton Beach Tramway, Madeira Road, Brighton. *Manager and Eng.*, M. Volk; *Traffic Manager*, W. Grulchfield; *Per. Way Eng.*, J. Barber; *Directors*, M. H. Volk, W. Grulchfield.
E Aug., 1883; 1·5 mi. route; 1·75 mi. track; 2 ft. 8½ in; 85 lb. Vig; max. grad., 1 in 100; min. radius, 200 ft.; third rail system; feeders, rubber and lead covered; 8 s. deck 4-wheel cars; motors, Siemens and B.T-H. 12 h.p. Power is taken from the Brighton Corp. elec. works at 1d. per unit. Generators, 2 T. Parker, Ltd., and Johnson & Phillips; Crossley gas engine; total, 50 kw. [4-5]

Bristol Tramways and Carriage Company, Ltd., Clare Street House, Bristol. *Traffic Manager*, Chas. Challenger; *Engineer in Chief*, J. Clifton Robinson; *Electrical Engineers*, W. H. Dixon and W. H. Munton; *Permanent Way Engineer*, G. T. C. Edwards; *Secretary*, H. F. Cooper; *Chairman*, Sir G. White, Bart.; *Directors*, S. White (*Managing*), J. Wethered, J. Clifton Robinson.
E Oct., 1895; 29 mi. route; 51 mi. track, S.G.; 92½ lb. G; max. grad., 1 in 10; min. radius, 28 ft.; centre and side pole and span; 0 wire; swivel trolley; feeders, Callender's; 232 d. deck 4-wheel cars (also 29 trail cars); car bodies, Milnes; motors, B.T-H., 25 h.p.; trucks, Peckham, Brill, Maguire; 6 B.T-H. generators; engines, 4 Allis and 4 Belliss; boilers, 4 Lancs.; 2,150 kw.

British Electric Traction Company, Ltd., Donington House, Norfolk Street, Strand, London, W.C. *Directors*: Sir C. Rivers Wilson, G.C.M.G., C.B. (chairman), the Hon. Sir Chas. W. Fremantle, K.C.B., C. Shirreff B. Hilton (Managing Director), J. S. Raworth (Technical Director), W. L. Madgen (Managing Director), E. Garcke (Managing Director). *Secretary*, C. H. Dade; *Accountant*, C. Walmsley.
(This company has made arrangements for the adoption of electric traction in various localities, and holds shares in a large number of existing tramway and analogous companies.)

Camborne and Redruth Tramways, (owned and worked by Urban District Elec. Supply Co.), Broadway Chambers, London, S.W., and Electricity Works, Carn Brea, Cornwall. *Manager and Eng.*, F. S. Hanning; *Sec.*, C. F. Jones; *Chairman*, F. Gripper; *Directors*, E. Charrington, H. B. Grorian, W. Page, J. C. Wigham.
E Nov., 1902; 3·75 mi. route; 4·9 mi. track; 3 ft. 6 in.; 90 lb. G.; max grad., 1 in 15; min. radius, 40 ft.; side poles; 000 wire; swivel trolley; contrs. for overhead equip., Edmundson Elec. Corp.; feeders, Callender's V.B. solid; 6 d. and 2 s. deck 4-wheel cars (2 elec. locos. and 12 mineral trucks); car bodies, G. F. Milnes & Co.; motors, 25 h.p. B.T-H.; trucks, Milnes & Co.; current from Urban Supply Co. at 1½d per unit; generators, 5 D.-C. Parkers; engines, 4 Belliss high-speed enclosed; boilers, 2 Lancs., Cornwall Boiler Co., 1 B. & W.; total, 480 kw. [4-5]

Carlisle Tramways Company, Ltd., City of, 1, Warwick Road, Carlisle. *Manager and Secretary*, George Cook; *Chairman*, T. D. Lingard; *Directors*, Geo. Readman, R. B. Barningham, R. Creighton, J. B. Glenn.
E June, 1900; 7·25 mi. route; 8·5 mi. track; 3 ft. 6 in.; 83 lb. G.; max. grad., 1 in 20; min. radius, 30 ft.; side trolley; contrs. overhead work, Dick, Kerr & Co.; feeders, Callender's; 12 d. deck and 3 s. deck cars; car bodies, Elec. Try. & Ry. Car. Works; 20 h.p. Dick, Kerr motors; Brill trucks. Current from Carlisle Corporation Electricity Works at 1½d. per unit. [11-4]

Chatham and District Light Railway Company, Luton Road, Chatham, and 83, Cannon Street, London, E.C. *Manager and Elec. Eng.*, W. Jensen; *Traffic Manager*, W. G. Davis; *Consulting Eng.*, Chas. H. Merz; *Per. Way Eng.*, C. J. Charlton; *Secretary*, A. Clements; *Chairman*, A. R. Monks; *Directors*, H. C. Levis, J. F. Nantheim, W. H. Whaite, W. B. H. Martindale.
E June, 1902; 9·33 mi. route; 17·19 mi. track; 3 ft. 6 in.; 92·5 lb. G.; max. grad. 1 in 9; min. radius, 35; side poles; 00 wire; swivel trolley; contrs. for overhead equip., B.T-H. Co.; feeders, Glover; 35 d. deck 4-wheel cars; car bodies, Milnes and Brush; trucks, Brill and Brush; motors, B.T-H. 28 h.p.; generators, 4 B.T-H.; engines, 3 Yates and Thom hor., and 1 Belliss and Morcom vert.; boilers, 4 Lancs., Yates & Thom; total 675 kw. [1-5]

Cheltenham and District Light Railway Company, St. Mark's, Cheltenham. *Manager and Elec. Eng.*, H. J. McCormick; *Per. Way Eng.*, P. J. Fagan; *Secretary*, H. V. Jackson; *Chairman*, Thomas A. Nevins; *Directors*, H. J. McCormick, W. G. Gurney.
E Aug., 1901; 6 mi. route; 6 mi. track; 3 ft. 6 in.; 83 lbs. G.; max. grad., 1 in 8; min. radius, 40 ft.; side poles; 00 wire; swivel trolley; contrs. for overhead equip., T. Nevins & Son; feeders, Geoffroy & Delore; 10 d. and 2 s. deck 4-wheel cars; car bodies, J. Stephenson & Co.; trucks, Peckham; motors, Westinghouse 40 B. 30 h.p.; current taken from Cheltenham Corp. at 1·9d. per unit. [9-4]

Clontarf and Hill of Howth Tramroad Company, 39, Dame Street, Dublin. *Secretary*, J. P. Chapman; *Chairman*, Sir Francis W. Brady; *Directors*, M. F. Mahony, J. E. Martin, W. L. Murphy.
E July, 1900; 5·5 mi. route; 6·5 mi. track; 5 ft. 3 in.; 87 lb. G.; max. grad., 1 in 18; min. radius, 34 ft.; side poles and brackets; swivel trolley; feeders, National Conduit and Cable Co.; 12 d. deck bogie cars; car bodies, Elec. Try. & Ry. Car. Works; B.T-H. motors; Peckham trucks. Current taken from station of Dublin United Tramway Co. at 1½d. per unit. [4-5]

Colne and Trawden Light Railways Company, Keighley Road, Colne. *Manager and Eng.*, M. Turner; *Per. Way Eng.*, J. H. Rhodes; *Chairman*, A. Greenwood.
E Nov., 1903; 3·5 mi. route; 3·7 mi. track; 4 ft.; 102 lb. G.; max. grad., 1 in 13; min. radius, 60 ft.; side pole and bracket arms; 000 wire; swivel trolley; contrs., Greenwood & Batley; feeders, W. T. Glover & Co.; 7 d. deck single truck cars; car bodies, Milnes & Co.; motors, B. T-H 28 h.p.; trucks, Milnes & Co. Power supplied by the Colne Corporation. [9-4]

Cork Electric Tramways and Lighting Company, Ltd., Albert Street, Cork. *Manager and Engineer*, H. H. Nalder; *Traffic Manager*, H. G. Whiting; *Per. Way Engineer*, H. G. Mack; *Secretary*, A. Clements; *Chairman*, A. R. Monks; *Directors*, W. Anderson, Sir T. Thompson, Bart., W. M. Murphy, W. B. H. Martindale, H. C. Levis.
E Dec., 1898; 9·89 mi. route; 15 mi. track; 2 ft. 11½ in.; 83 lb. G.; max. grad., 1 in 13; min. radius, 28 ft.; centre and side pole; 0 and 00 wire; swivel trolley; contrs. overhead equip., R. W. Blackwell & Co.; feeders, Callender's armoured; 35 d. deck 4-wheel cars; car bodies, Brush; B.T-H. 19 h.p. motors; Peckham trucks; current obtained from own station at a cost of ·55d. per unit; 6 B.T-H. multipolar generators; engines, 3 Macintosh & Seymour, 2 Allis and 1 Belliss & Morcom; boilers, 6 tubular B. & W.; 300 kw. [6-5]

Coventry Electric Tramway Company, Ltd., Priestley's Bridge, Coventry, (and 20, Bishopsgate Street Within, London, E.C.). *Resident Engineer and Manager*, T. R. Whitehead; *Assist. Manager*, R. Orton; *Cons. Eng.*, I. E. Winslow; *Secretary*, J. G. Mills; *Chairman*, Baron E. B. d'Erlanger; *Directors*, E. A. Hopkins, F. Fitzgerald, Hon. A. G. Brand.
E Dec., 1895; 13·25 mi. route; 15·75 mi. track; 3 ft. 6 in.; 65 & 84 lb. G.; max. grad., 1 in 16; min. radius, 40 ft.; cross and side suspension; 0 wire; fixed trolley; contrs. overhead equip., R. W. Blackwell & Co.; feeders, B.I.W.; 30 d. deck 4-wheel cars; car bodies, Brush, Dick-Kerr; motors, Westinghouse and Dick, Kerr & Co.; Peckham trucks; generators, 4 Westinghouse, 100 kw.—2 D.C., and 2 belt-driven; engines, Browett, Lindley & Co., 4 150 h.p. hor. comp.; boilers, B. & W. water tube, 2 106 h.p. and 2 175 h.p. (total 400 kw.) [4-5]

Croydon Corporation Tramways (Leased to the British Elec. Traction Co.), Tramway Depôt, Thornton Heath, Surrey, and Donington House, Norfolk St., London, W.C. *General Manager*, T. B. Goodyer; *Supt.*, C. G. Foster; *Eng.*, H. B. Harris; *Secretary*, H. Atkinson Clarke; *Chairman*, J. Devonshire; *Directors*, H. C. Levis, S. A. Sillem, C. S. B. Hilton, C. G. Tegetmeier.
E Sep., 1901; 10·71 mi route; 17·13 mi. track; S.G.; 95·5 lb. G.; max grad. 1 in 20; min. radius, 40 ft.; side wire; 00 wire; swivel trolley; contrs. for overhead work, B.T-H. Co.; feeders, Callender's; 60 d. deck cars (45 4-wheel and 15 bogie); car bodies, Milnes and Brush; motors, B.T-H. 30 h.p. (GE. 52); trucks, Peckham, Brill, Milnes, and Brush. Current taken from

(*Continued on page xlviii.*)

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ELECTRIC TRAMWAY AND RAILWAY DIRECTORY—*continued.*

Corporation Electricity Works at 2d. per unit. Generators, 2 B.T-H. multipolar and 1 E.C.C.; engines, 3, Belliss (total 700 kw.) [4-5]

Derby—Ashbourne Tramways. *Elec. Eng.*, J. F. Albright.

E (under cons.); 14·5 mi. route: S.G.

Devonport and District Tramways Company, Ltd., Tramway Depot, Milehouse, Devonport, and Donington House, Norfolk St., London, W.C. *Manager & Elec. Eng.*, J. W. Endean; *Secretary*, P. N. Gray; *Chairman*, W. G. Bond; *Directors*, J. F. Albright, J. S. Raworth, C. S. Hilton.

E June, 1901; 8·5 mi. route; 15·5 mi. track; 3 ft. 6 in.; 92 lb. G.; max. grad., 1 in 8; min. radius, 30 ft.; side and centre poles; 0 and 00 wire; swivel trolley; contrs. overhead equip., R. W. Blackwell & Co.; feeders, Glover & Co.; 25 d. deck 4-wheel cars; car bodies, Brill and Brush; motors, B.T-H., and Brush 1,000 A 35 h.p.; trucks, Brill 21 E and Brush Standard. Current taken from Devonport Corporation Electricity Works at 1·8d. per unit. [4-5]

Dewsbury, Batley, and Birstall Tramways Company, Ltd., Donington House, Norfolk Street, London, W.C., worked by Yorkshire (Woollen District) Electric Tramways, Ltd., *q.v.*

Douglas—Ramsey. (The Manx Elec. Rly. Company), 1, Strathallan Crescent, Douglas, Isle of Man. *Manager*, Harold Brown; *Resident Eng.*, F. Edmondson; *Secretary*, C. A. Huni; *Directors*, A. G. Kitching (chairman), W. H. Vaudrey, B. E. Greenwell, E. Schenk, A. G. Boscawen.

E 1898; 18 mi. route; 35·75 mi. track; 3 ft.; 62½ lbs. Vig.; max. grad., 1 in 24; min. radius, 90 ft.; centre and side poles and span wire; 0 wire; feeders, Callender's and Henley's; 22 motors (also 23 trailers) and 1 loco.; car bodies, Milnes & Co.; trucks, Milnes & Co.; motors, 25 h.p. Mather & Platt, and 20 h.p. E.C.C.; current from 3 power stations and 2 substations; generators, 4 Mather & Platt bi-polar type, and 3 E.C.C. multipolar, and 2 Witting Eborall; engines, 4 430 h.p. Bellis and Morcom, 3 180 h.p. Robb-Armstrong, and 4 120 h.p. D.C.; boilers, 11, Galloways; (total, 1,300 kw.) [4-5]

Douglas Southern Electric Tramways, Marine Drive, Douglas, Isle of Man. 2, Atlantic Chambers, Brazennose Street, Manchester. *Manager and Eng.*, F. W. Ketley; *Sec.*, J. E. Sharples; *Chairman* T. J. Hutchinson; *Directors*, J. E. Winslow, W. Davenport, E. A. Hopkins.

E Aug., 1896; 3·75 mi. route; 3·75 mi. track; S.G.; 65 lb. Vig.; max. grad., 1 in 12; min. radius, 45 ft.; span wires; 0 wire; swivel trolley; contrs. overhead equip., General Traction Co.; 8 d. deck 4-wheel cars (also 8 trailers); car bodies, Brush; trucks, Baltimore; motors, Westinghouse and B.T-H. 25 h.p.; generators, 2 six-pole Westinghouse; engines, Browett, Lindley, single cylinder; boilers, B. & W.; total 200 kw. [6-4]

Dublin and Lucan Electric Railway Company, 15, Conyngham Road, Dublin. *Manager and Elec. Eng.*, H. Harrison; *Traffic Manager*, J. Loane; *Per. Way Eng.*, W. F. Clarke; *Secretary*, H. Harrison; *Chairman*, Wm. Mooney; *Directors*, J. W. Hill, W. F. Clarke, Capt. C. C. Vesey, J. E. Palmer

E April, 1900; 6·75 mi. route; 6·875 mi. track; 3 ft. 6 in.; 50 lb. Vig.; max. grad., 1 in 20; min. radius, 27 ft.; side poles; 00 wire; swivel trolley; contrs. overhead equip., Dick, Kerr & Co.; 5 d. deck bogie cars (also 16 trail cars and 18 wagons); car bodies, Milnes; motors, 20 h.p., Dick-Kerr; Brill max. traction trucks; 2 Dick-Kerr generators; engines, 2, Ball & Wood hor. comp. cond.; boilers, 2, Lancs., Galloways; (total 240 kw.) [4-5]

Dublin United Tramways Company, 9, Upper Sackville Street, Dublin. *Manager*, C. W. Gordon; *Elec. Eng.*, P. S. Sheardown; *Per. Way Eng.*, P. F. O'Sullivan; *Secretary*, R. S. Tresilian; *Chairman*, W. M. Murphy; *Directors*, W. Anderson, W. F. Cotton, P. B. Bernard, S. Beeton.

E May, 1896; 47·65 mi. route; 92·5 mi. track; 5 ft. 3 in.; 92 lb. G.; max. grad., 1 in 12·37; min. radius 34·5 ft.; side and centre poles; 0 wire; swivel trolley; feeders, National Conduit Co., paper insulated; 291 d. deck and 3 s. deck 4-wheel cars; car bodies by D.U.T. Co.; motors, 18 to 27 h.p. B.T-H. (GE. 52 and 800); trucks, Peckham & Dupont; generators, B.T-H 6-500 volt GE. continuous and 1-2,500 volt alt. multipolar; engines, 6, Allis. vert. comp.; boilers, 12, B. & W. water tube; total 3,300 kw. [4-5]

Dudley, Stourbridge and District Electric Traction Company, Ltd. (Section of The Birmingham and Midland Tramways Joint Committee), Central House, New Street, Birmingham, Brierley Hill, Staffs., and Donington House, Norfolk Street, London, W.C. *Engineering Manager*, G. Conaty; *Traffic Manager*, R. W. Cramp; *Eng.*, R. N. Tweedy; *Secretary*, W. F. Herring; *Assist. Secretary*, B. Kingsford; *Chairman*, C. S. Hilton; *Directors*, T. A. Lycett, A. C. Miles.

E July, 1899; 21·25 mi. route; 27·22 mi. track; 3 ft. 6in.; 90 G.; max. grad., 1 in 11; min. radius, 0·75 ch.; span and centre poles; 0 wire; fixed trolley; contrs. overhead equip., B.T-H. Co. and J. G. White & Co.; feeders, Callender's, solid system, and B.I.W.; 24 d. deck, 33 s. deck cars (14 with bogie and 43 with 4 wheel trucks); car bodies, Brush and Dick, Kerr & Co.; motors, Brush and B.T-H. 25 h.p.; trucks, Brill, Brush, Baltimore and Peckham. Generators, 3 B.T-H. and 1 Brush 6-pole 100 kw.; engines, 3, Ball & Wood, 1 hor. tand. comp. 175 h.p. Diesel; boilers, 3, Lancs., H. & T. Danks; 400 kw. [4-5]

Dundalk Electric Tramway Company, 118, Grafton Street, Dublin. *Engs.*, J. H. Ryan and A. M. Taylor; *Sec.*, R. N. Metcalfe; *Directors*, F. W. Crossley, W. Nolan, R. M. D. Sanders, D. T. Wilson, M. Nugent.

E (Under cons.); 6 mi. route; 6·25 mi. track; 3 ft. 6 in.; 97 lb. G. and 65 T.; max. grad. 1 in 10; min radius, 50 ft.; side poles; 12 cars.

Gateshead and District Tramway Company, Gateshead, and Donington House, Norfolk Street, London, W.C. *Manager*, William Morrison; *Secretary*, W. J. Charlton; *Assist. Sec.*, W. F. Cox; *Chairman*, C. R. Greene; *Directors*, W. J. Greer, L. A. Atherley-Jones, W. L. Madgen, H. S. Day.

E May, 1901; 11·28 mi. route; 17·30 mi. track; 3 ft. 8½ in.; 90 lb. G.; max. grad., 1 in 8; min. radius, 35 ft; span, centre and side poles; 00 wire; swivel trolley; contrs. for overhead equip., Blackwell & Co.; feeders, Callender's; 25 d. and 25 s. deck cars; car bodies, Dick, Kerr & Co. and Milnes & Co.; motors, Dick, Kerr & Co., 35 h.p.; trucks, Brill. Current is taken from County of Durham Electric Power Distribution Co. Generators, Brush; engines, Brush Universal; boilers, B. & W. [4-5]

Glossop Urban District Tramways, Glossop (leased and worked by the Urban Electric Supply Co.) *Manager and Elec. Eng.*, C. E. Knowles.

E Aug. 1903; 4·5 mi. route; 5 mi. track; S.G.; 90 lb. G.; max. grad., 1 in 14; min. radius, 40 ft.; side poles; contrs. overhead equip., Edmondson's Elec. Corp.; feeders, Callender's; 6 d. deck cars; car bodies and trucks, Milnes & Co.; motors, B.T-H. (GE. 58); current taken from lighting works. Generators, 2, pole shunt, Parker; engines, 2—135 h.p. and 1-70 h.p. Belliss and Morcom; boilers, 2, Davey-Paxman; total 225 kw.

Gravesend & Northfleet Electric Tramways, Ltd., Fern Crescent, Dover Road, Northfleet, Kent, and Donington House, Norfolk Street, London, W.C. *Manager*, A. W. Kipping; *Sec.*, P. N. Gray; *Chairman*, W. G. Bond; *Directors*, J. F. Albright and A. C. Miles.

E Aug., 1902; 6·5 mi. route; 9·5 mi. track; S.G.; 87 G.; max. grad., 1 in 11; min. radius, 55 ft.; side poles; 0 wire; fixed trolley; contrs. overhead equip., Wm. Griffiths & Co.; feeders, General Electric Co.; 16 d. deck and 2 s. deck, 8 bogie and 10 4-wheel cars; car bodies, English Elec. Mfg. Co.; motors, Dick Kerr & Co., 25 and 35 h.p.; trucks, Brill, 21 E. and Brush Co. Current taken from Gravesend Corp. elec. works at a scale of 2d., 1¾d., and 1½d. per unit. [4-5]

Great Crosby Tramways, 31, James Street, Liverpool. *Chairman*, J. H. Goodyear.

E June, 1900; 2·5 mi. route; 2·5 mi. track; S.G.; 92½ lb. G.; min. radius, 45 ft.; 0000 wire; swivel trolley; contrs. overhead equip., R. W. Blackwell and Co. (This tramway is worked by the Liverpool Overhead Rly. Co., and is included in the particulars given below under the name of that company.) [9-4]

Great Grimsby Street Tramway Co., Cleethorpes, and 74, Cheapside, London, E.C. *Manager*, H. L. White; *Elec. Eng.*, S. Barnes; *Cons. Eng.*, John Glenn; *Managing Director and Secretary*, J. B. Glenn; *Chairman*, A. Beattie; *Directors*, A. W. White, J.P., S. Hern.

E Dec., 1901; 6 mi. route; 10·11 mi. track; S.G.; 96 lb. G.; max. grad. 1 in 15; min. radius, 26 ft.; side and centre poles; 0 wire; swivel trolley; contrs. for overhead work, Dick, Kerr & Co.; feeders, B.I.W.; 30 d. deck 4-wheel cars and 6 trailers; car bodies, Dick, Kerr & Co.; motors, Dick, Kerr & Co., 25 h.p.; trucks, Brill (21 E.). Current partly taken from Grimsby elec. works at 1½d. per unit, and partly from own station. Engines, Robb, Armstrong, and Co.; boilers, 2 Lancs., Penman & Co.; generators, 2 multipolar Dick, Kerr & Co. 150 kw. (total 300 kw.) [4-5]

Greenock and Port Glasgow Tramways Company, Ladyburn, Greenock, and Donington House, Norfolk Street, London, W.C. *Manager*, A. A. Hawkins; *Elec. Eng.*, C. U. Kerr; *Secretary*, W. F Herring; *Chairman*, Viscount Emlyn; *Directors*, C. S. B. Hilton, F. B. Lea, D. J. Dunlop, R. P. Simpson.

E Oct. 1901; 7·75 mi. route; 15 miles track; 4 ft. 7½ in.; 90 lb. G.; max. grad., 1 in 15; min. radius, 38 ft.; side and centre poles; 00 wire; swivel trolley; contrs. overhead equip., Geo. Hill & Co.; feeders, Callender's; 30 d. deck bogie and 6 s. deck 4-wheel cars; car bodies, Brush; motors, Brush 1000 A. 25 h.p.; trucks, Brush Standard and Radial. Current is taken from Greenock Corp. Elec. Works at 1½d. per unit. [4-5]

Guernsey Railway Company, Hougue-à-la-Perre, Guernsey. *Manager and Elec. Eng.*, Albert L. Davis; *Sec.*, J. de Mouilpied; *Chairman*, G. F. Peek; *Directors*, W. D. Murdoch, A. C. Quick, T. Stedman, J. B. Collings.

E Nov., 1892; 2 mi. route; 3 mi. track; 3 ft. 8½ in.; 40 and 74 lb. Vig., and 84 G.; max. grad. 1 in 60; min. radius, 60 ft.; side poles; ·354 wire; fixed trolley; contrs. overhead work, Siemens, Bros. & Co.; 9 d. deck and 2 s. deck cars (4 bogie and 6 4-wheel trucks); car bodies, Milnes and Brush; motors, Siemens and B.T-H. GE. 800 14 h.p.; trucks, Peckham; 2 Siemens' comp. generators; engines, 2 comp. con. Marshall & Co.; boilers, 2 Marshall's and 2 B. & W.; total, 100 kw. [4-5]

Hampshire Light Railway (Electric) Company, 74, Cheapside, London, E.C. *Secretary*, J. B. Glenn; *Eng.*, John Glenn.

E March, 1903; 6 mi. route; 9 mi. track; S.G.; 10 d. deck cars; current obtained from the Portsmouth Corp. try. power-station.

Hartlepool Electric Tramways Company, W. Hartlepool, and Donington House, Norfolk St., London, W.C.; *Manager*, W. H. Bettison; *Secretary*, W. J. Charlton; W. F. Cox, *Assist. Secretary*; *Chairman*, W. J. Greer; *Directors*, W. G. Bond, W. Morrison.

E May, 1896; 6·72 mi. route; 8·30 mi. track; 3 ft. 6 in.; 87 lb. G.; max. grad. 1 in 15; min. radius, 35 ft.; side and centre pole and span; 00 wire; swivel trolley; contrs. for overhead work, Macartney, McElroy & Co., R. W. Blackwell & Co., and Elec. Con. Co.; feeders, Callender's solid; 21 d. deck cars (8 bogie and 13 4-wheel cars); car bodies, Dick Kerr, Brush, and Milnes; motors, Dick, Kerr & Co., 35 h.p. (35 A 1); trucks, Brill and Brush. Current from own station, at a cost of ·75d. per unit; generators, 2 bipolar E.C.C. and 2 multipolar Mather & Platt; engines, 4 Willans' vert. comp.; boilers, 2 Galloway's, 1 Tinker's; (total 500 kw.) [4-5]

Hastings and District Electric Tramways Company, Ltd., 1, Queen Victoria Street, London, E.C. *General Manager*, T. B. Holliday; *Secretary*, W. R. Elston; *Directors*, E. C. Morgan (chairman), G. Kitchin, J. C. Williamson.

E (Under cons.), 19·25 mi. route; 30·25 mi. track; 3 ft. 6 in.; contrs. elec. equipment, Dick, Kerr & Co. [12-4]

Herne Bay Pier Company, Ltd., Herne Bay. *Manager*, Henry C. Jones. *Directors*, R. P. Taylor (*chairman*), J. Barnwell, J. Hogbin, E. D. Collar, A. M. Wacher, F. W. Wacher.

E March, 1899; ·75 mi. route (on pier); ·75 mi. track; 3 ft.; 20 lb. V.; third rail; 3 s. deck cars; car bodies, Milnes & Co.; motors, B.T.-H.; trucks, Peckham. [6-4]

Imperial Tramways Company, Ltd., Clare Street House, Bristol. *Directors*, Sir George White, Bart. (*chairman*), H. C. Godfray, S. White, J. Clifton Robinson, J.P. (*managing*); *Secretary*, W. G. Verdon Smith, *Engineer*, J. Clifton Robinson. [4-5]

Isle of Thanet Electric Tramways and Lighting Company, Ltd., St. Peter's, Kent, and 74, Cheapside, London, E.C. *Manager and Elec. Eng.*, R. Humphries; *Traffic Manager*, J. Standing; *Per. Way Eng.*, W. Paterson; *Secretary*, J. Barber Glenn; *Chairman*, Lord Arthur Butler; *Director*, W. Murphy.

E April, 1901; 9 mi. route; 11 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad., 1 in 11; min. radius, 30 ft.; side pole; 0 wire; swivel trolley; contr. for overhead equip., W. M. Murphy; feeders, B.I.W. solid system; 60 d. deck 4-wheel cars; car bodies, St. Louis Car Co. & B.T-H.; motors, 35 h.p., B.T-H. (GE. 58); trucks, Brill and St. Louis Car Co.; generators, 2 B.T-H. 550 volt continuous, and 2 2,500 volt alt.; engines, 2 Allis, 2 Belliss and Morcom vert.; boilers, 4 water tube B. & W.; total, 1,000 kw. [4-5]

Kidderminster and Stourport Electric Tramway Company, Kidderminster and Donington House, Norfolk Street, London, W.C. *Managing & Elec. Eng.*, G. Charlton; *Traffic Manager*, W. Steadman; *Assist. Elec. Eng.*, J. F. Coates; *Secretary*, H. A. Stagg; *Chairman*, W. L. Madgen; *Directors*, J. A. Lycett (managing), H. R. Arnold, Sir E. Spencer.

E May, 1898; 4·5 mi. route; 4·75 mi. track; 3 ft. 6 in.; 75 lb. G.; max. grad., 1 in 14; min. radius, 45 ft.; brackets, side trolley; 0 wire; swivel trolley; contrs. for overhead equip., Brush Co.; feeders, Glover & Co.; 4 d. deck and 9 s. deck cars (4 open and 5 closed); car bodies, Brush and Dick-Kerr; motors, Brush and Walker, 17, 25, and 27 h.p.; trucks, Brill 21 E., Baltimore, and Brush. Current is taken from the Kidderminster Elec. Lighting Co.; generators, 5, Brush and Parsons; engines, 5, Brush and Parson's turbines; boilers, 5, B. & W.; 900 kw. [4-5]

Kinver Tramway, Kinver, and Donington House, Norfolk Street, London, W.C. *Chairman*, E. Garcke. *q.v.*, Dudley, Stourbridge, and District Elec. Traction Co., Ltd.

Lanarkshire Tramway Company, Edinburgh Road, Motherwell, N.B., and 88, Cannon Street, London, E.C. *Gen. Manager*, G. F. Moller; *Traffic Manager*, W. G. Davis; *Sec.*, A. Clements; *Chairman*, A. R. Monks; *Directors*, Sir B. Cunard, H. C. Levis, W. H. Whaite, G. Franklin, J. F. Nauheim, Sir T. R. Thompson.

E July, 1903; 8·63 mi. route; 15·08 mi. track; 4 ft. 7½ in.; 96 lb. G.; max. grad., 1 in 11·2; min. radius, 36 ft.; side bracket poles; 00 wire; swivel trolley; contrs. overhead equip., B.T-H. Co.; feeders, St. Helen's Cable Co. dialite, solid; 25 d. deck 4-wheel cars; car bodies, British Elec. Car. Co.; motors, B.T-H. Co., 27 h.p.); trucks, British Electric Car Co.; generators, B.T-H. Co. 3 8-pole 250 kw., and 1 4-pole 75 kw.; engines, 3 Yates & Thom, comp. cond. Corliss, and 1 Allen & Sons, high speed comp.; boilers, 3 B & W. water tube; total, 825 kw. [6-4]

Lancashire Light Railway Company, Ltd. (Liverpool-Prescot Light Railway), 9, North John Street, Liverpool. *Engineer-in-Chief*, J. R. Salter; *Secretary*, H. P. Conibear; *Chairman*, Hon. A. Stanley, M.P.; *Directors*, E. K. Muspratt, C. E. Maples, E. Adam, J. Beecham, and J. M. Henderson.

E June, 1902; 3·41 mi. route; 3·625 mi. track; S.G.; 100 lb. G.; max. grad., 1 in 20; min. radius, 50 ft.; side poles; 00 wire; swivel trolley; contrs. overhead equip., B.I.W. Co.; feeders, B.I.W. Co.; 7 d. deck 4-wheel cars; car bodies and trucks, Milnes, and British Electric Car Co.; motors, Witting and Westinghouse, 30 h.p. Current from B.I.W. Co. at 1½d. per unit. [6-5]

Liverpool Overhead Railway Company, 31, James Street, Liverpool. *Manager and Elec. Eng.*, S. B. Cottrell; *Secretary*, W. H. Alexander; *Chairman*, Sir W. B. Forwood; *Directors*, R. Hobson, H. Brocklebank, Sir E. Lawrence, G. H. Robertson, H. C. Woodward, J. E. Anderson.

Besides the Liverpool Overhead Railway this Company works a section of electric tramway as follows:

E June, 1900; 2·5 mi. route; 2·5 mi. track; S.G.; 92½ lb. G.; no grad.; min. curve, 45 ft.; side pole; 0000 wire; swivel trolley; contrs. for overhead equip., R. W. Blackwell & Co.; feeders, Glover's; 12 d. deck and 2 s. deck 4-wheel cars; car bodies, Dick, Kerr & Co.; motors, 25 h.p. Dick-Kerr; trucks, Brill 21 E.; generators, 7, British Schuckert Co., E. C. C. & T. Parker; engines, 7 Musgrave & Sons, Hick, Hargreaves, Browett-Lindley; boilers, 7, Lancs., Musgrave & Sons; total 160 kw. [4-5]

(*Continued on page l.*)

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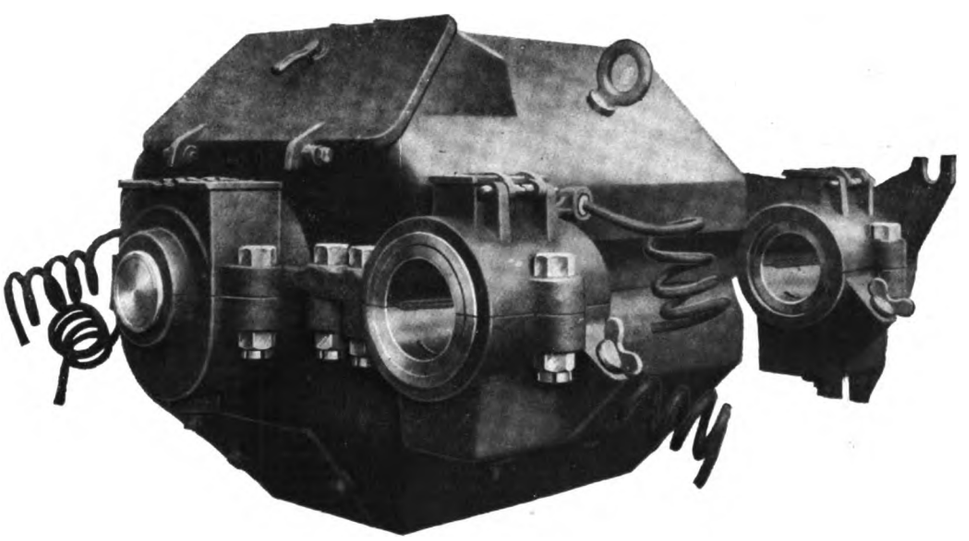
Bruce Peebles

& Co., Ltd.



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ELECTRIC TRAMWAY AND RAILWAY DIRECTORY—*continued.*

Liverpool-Prescot Light Railway Company, 9, North John Street, Liverpool. *Manager and Elec. Eng.*, J. R. Salter; *Sec.*, H. P. Conibear; *Chairman*, Hon. Arthur Stanley, M.P.; *Directors*, C. E. Maples, E. Adams, E. K. Muspratt, M.P., J. Beecham, J. M. Henderson. (See Lancashire Light Railway Company, Ltd.) [4-5]

Llandudno, Colwyn Bay, and Rhyl Electric Traction Company, 33, Brazennose Street, Manchester. *Engineer*, W. G. Rhodes; *Secretary*, J. Morris; *Directors*, E. Hewitt, F. W. Smith, W. J. Kershaw.

E (Under cons.): 2 mi. route; 8·5 mi. track; 3 ft. 6 in.; 86 lb. G.; max. grad. 1 in 13; min radius, ; bracket and span wire; 00 wire; fixed trolley; contrs. overhead equip., F. W. Smith & Co.; 16 cars; motors, 25 h.p. Current to be obtained from Llandudno Corporation at 1·5 per unit. [4-5]

London United Tramways (1901) Ltd., 88, High Road, Chiswick. *Managing Director and Resident Eng.*, J. Clifton Robinson; *Traffic Manager*, Clifton Robinson, jun.; *Sec.*, W. G. Verdon Smith; *Chairman*, C. J. Cater-Scott; *Directors*, W. Abbott, J. Clifton Robinson, W. H. Brown, C. T. Yerkes.

E April, 1901; 37·09 mi. route; 62 mi. track; S.G.; 92½ lb. G.; max. grad., 1 in 19; min. radius, 32 ft.; side and centre poles and span wires; 00 wire; swivel trolley; feeders, Nat. Conduit & Cable Co., & W. T. Henley's; 300 d. deck bogie cars; car bodies, Milnes & Co., Hurst, Nelson & Co., and British Elec. Car Co.; motors, B.T-H. 25 h.p., and Westinghouse 30 h.p.; trucks, Peckham, McGuire, and Brill; generators, 4 250 kw. and 1 500 kw. and 2 1,000 kw. 3-phase, B.T-H.; engines, 5, Allis-Chalmers, vert. Corliss; boilers, 11, B. & W., with Vicars' stokers; total, 3,500 kw. [4-5]

Mansfield & District Light Railway Co., Bentinck Chambers, Mansfield, and 5, Great George Street, London, S.W. *Gen. Manager*, C. R. Walker; *Con. Eng.*, H. Graham Harris; *Sec.*, G. D. Prince; *Directors*, W. S. B. McLaren (*chairman*), A. R. Holland, M. H. Mills, G. Wigley, J.P., H. Rüffer.

E Under cons.; 10 mi route; 11·5 mi. track; S.G.; 90 lb. G; max. grad., 1 in 17; min. radius, 50 ft.; side bracket; 00 wire; swivel trolley; contrs. overhead equip., J. G. White & Co.; feeders, solid; trucks, single; motors, 25 h.p.; current from Mansfield Corporation; generators, 3 multipolar, T. Parker, Ltd.; engines, 3 T. Cp. Alley McLellan, 400 h.p.; boilers, 3 Lancs. 30 ft. by 8 ft., Musgrave & Co., and 3 B. & W.; total, 300 kw. [1-5]

Manx Electric Railway Company, 1, Strathallan Crescent, Isle of Man, and 78, Cornhill, London, E.C. *Directors*, A. G. Kitching (*chairman*), W. H. Vaudrey, B. E. Greenwell, E. Schenk, A. G. Boscawen; *Secretary*, C. A. Huni. (See Douglas-Ramsey Tramway and Snaefell Mountain Railway.) [4-5]

Merthyr Electric Traction and Lighting Company, Donington House, Norfolk Street, London, W.C. *Managing Eng.*, A. J. L. Plunket; *Secretary*, H. A. Stagg; *Chairman*, W. L. Madgen; *Directors*, C. G. Tegetmeier, G. R. Hulme.

E April, 1901; 2·98 mi. route; 3·94 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad., 1 in 10; min. radius, 38 ft.; span wire and side poles; 0 wire; fixed trolley; feeders, Callender's; 3 d. and 12 s. deck 4-wheel cars; car bodies, Midland Wagon Co., and Dick, Kerr & Co.; trucks, Brill 21 E.; motors, B.T-H. Co. 35 h.p. and Dick, Kerr & Co. (33 N.) 25 h.p.; current obtained from lighting section of company at 1½d. per unit; generators, 3 110 kw. 4-pole Bruce Peebles and 1 300 kw. 6-pole Silvertown; engines, 4, Browett, Lindley; boilers, 4, B. & W.; (total 500 kw.) [4-5]

Metropolitan Electric Tramways, Limited, Evelyn House, Finsbury Pavement, London, E.C. *Traffic Manager*, W. E. Hammond; *Chief Eng.*, A. H. Pott; *Per. Way Eng.*, S. G. Smith; *Secretary*, A. L. Barker; *Chairman*, E. Garcke; *Directors*, Sir E. Spencer (*Deputy Chairman*), J. Goddard, W. L. Madgen, G. Richardson, C. G. Tegetmeier, J. Devonshire (*Managing Director*).

E July, 1904; 15 mi. route; 30 mi. track; S.G.; 100 lb. G.; max. grad., 1 in 15; min. radius, 40 ft.; span wire and centre pole; 000 wire; swivel trolley; feeders, Callender's L.T.-V.B. Sheath laid solid; 150 d. deck bogie cars; car bodies, Brush Co.; motors, B.T-H., 28 h.p.; trucks, Brush Co. Current taken from North Metropolitan Elec. Power Supply Co. at 1·4d. per unit for first 5,000,000 in each half-year with sliding scale. Generators, 3, Brown Boveri, 1000 kw.; engines, 3, Parsons, turbines, Bellis, B.T-H. exciters; boilers, 6, B. & W. (15,000 lbs. evaporation); 3,000 kw. [12-4]

Middlesbro, Stockton, and Thornaby Electric Tramway Company, Middlesbro, and Clare Street House, Bristol. *Managing Director and Engineer*, J. Clifton Robinson: *Chairman*, Sir Geo. White, Bart.: *Directors*, J. Clifton Robinson, H. C. Godfrey, S. White.

E July, 1898; 8·5 mi. route; 15 mi. track; 3 ft. 6 in.; 92 lb. G.; max. grad., 1 in 17; min. radius. 30 ft.; centre and side poles; 50 d. deck and 10 s. deck (total 60 bogie truck cars); car bodies, Milnes; motors, B.T-H. (GE. 800); trucks, Peckham; generators, 3, B.T-H.; engines, 3, Allis hor. comp.; boilers, B. & W. 3; total 900 kw.

Middleton Electric Traction Company, Hiltonfold Lane, Middleton, and Donington House, Norfolk St., London, W.C. *Gen. Manager*, W. F. Endean; *Secretary*, W. S. Wreathall; *Chairman*, Lord Vaux of Harrowden; *Directors*, C. S. Hilton, J. V. Kitchener.

E March, 1902; 8·5 mi. route: 9·75 mi. track; S.G.; 98 lb. G.; max. grad., 1 in 18; min. radius, 45 ft.; side poles and span wire; 0 wire; fixed trolley; contrs. for overhead equip., Geo. Hill & Co.; feeders, W. T. Glover & Co.; 5 d. and 22 s. deck cars (14 with bogie and 13 with 4-wheel truck); car bodies, Dick, Kerr and Brush; motors, Dick-Kerr 25 h.p. and Brush 35 h.p.; trucks, Brill, Brush and Peckham. Current taken from Middleton Corp. elec. works at 1½d. per unit, sliding scale; generators, 3 Siemens, D-C; engines, 3, Belliss & Morcom; boilers, 3, Lancs. [3-5]

Musselburgh Electric Tramways, Electricity Works, Musselburgh, N.B. (owned by the National Electric Construction Co., 34, Victoria Street, London, S.W.) *Gen. Manager and Elec. Eng.*, William Bain; *Per. Way Eng.*, A. Ritchie; *Secretary*, W. B. Cownie; *Directors*, R. S. Bain (chairman), J. T. Jervis, B. Bornheim, L. B. Schlesinger, W. H. Fowler.

E December, 1904; 3 mi. route; 5·25 mi. track; S.G.; 90 lb. G.; max. grad., 1 in 34; min. radius, 48; bracket arm, side pole; 00 wire; swivel trolley; contrs. for overhead equip., National Elec. Cons. Co.; feeders, B.I.W.; 12 d. deck cars; car bodies, British Elec. Car Co.; motors, B.T-H. 30 h.p.; generators, 3 100 kw. Lancs. Dynamo and Motor Co.; engines, 2 Peache, Davey Paxman and Co.; boilers, 3 Heenan and Froude water-tube; 200 kw., set 800 amp. battery. [1-5]

New General Traction Company, Ltd., 20, Bishopsgate Street Within, London, E.C. *Managing Director*, E. A. Hopkins; *Secretary*, J. G. Mills; *Chief Engineer*, I. E. Winslow; *Chairman*, Baron E. B. d'Erlanger.

[This company holds shares in several tramway companies—among others, in the Coventry, the Norwich, and the Douglas Southern Electric Tramways Companies.] [4-5]

New St. Helen's and District Tramways Company, Ltd., Tramway Depot, Hall Street, St. Helen's. *General Manager*, Wm. Hutchings; *Secretary*, C. E. Ruckley; *Chairman*, J. B. Atherton; *Directors*, J. Atherton, H. Martin, L. Higginbottom, J. Hunter.

E July, 1899; 20·25 mi. route; 22 mi. track; S.G.; 95 lb. G.; max. grad., 1 in 14; min. radius, 35 ft.; brackets and span wires; 0 wire; swivel trolley; contrs. for overhead equip., B.I.W. Co; feeders, B.I.W. Co.; 36 d. deck cars (20 bogie and 16 4-wheel trucks); car bodies, Brush; motors, B.T-H. and Westinghouse, 25 h.p.; trucks, Brill; current taken from St. Helen's Corp. elec. works at 1d. per unit. [4-5]

North Shields Tramway Company owned and worked by Tynemouth and District Elec. Trac. Co., *q.v.*

Norwich Electric Tramway Company, 8, Orford Hill, Norwich, and 20, Bishopsgate Street Within, London, E.C. *Manager and Engineer*, A. N. Banister; *Assist. Manager*, F. W. Dogget; *Consulting Eng.*, I. E. Winslow; *Sec.*, T. G. Mills; *Chairman*, Baron E. B. d'Erlanger; *Directors*, E. A. Hopkins (*Managing*), Hon. A. Brand, F. Fitzgerald, G. M. Chamberlain.

E July, 1900; 14·5 mi. route; 19·5 mi. track; 3 ft. 6 in.; 65·5 lb. G.; max. grad. 1 in 12·5; min. radius, 38 ft.; span wire (centre suspension); 0 wire; fixed trolley; contrs. for overhead equip., Blackwell & Co.; feeders, B.I.W. paper insulated; 42 d. deck 4-wheel cars; car bodies, Brush; motors, Westinghouse No. 46, 25 h.p.; trucks, Peckham. Current supply from own power-station at ·75d. per unit; 4 D-C. Westinghouse railway generators; engines, Browett, Lindley, 4, tandem, comp. cond.; boilers, 4 water tube, B. & W.: total 800 kw. [4-5]

Oldham, Ashton and Hyde Electric Tramway, Ltd., Tramway Depot, Denton, Lancs., and Donington House, Norfolk St., London, W.C. *Gen. Manager*, M. Rathborne; *Elec. Eng.*, E. T. Todd; *Secretary*, W. S. Wreathall; *Chairman*, E. Garcke; *Directors*, L. A. Atherley Jones, R. Whittaker, J. V. Kitchener, T. Hegmbottom.

E June, 1899; 9 mi. route; 9 mi. track; S.G.; 96 lb. G.; max. grad., 1 in 11; min. radius, 26 ft.; span wire and side poles; 0 wire; fixed and swivel trolleys; contrs. for overhead equip., Blackwell & Co.; feeders, B.I.W. and Glover & Co.; 12 d. deck and 34 s. deck 42 4-wheel cars and 4 bogie truck cars; car bodies, Brush; motors, Brush and B.T-H. (27 h.p., and B. 1,000, 35 h.p.); trucks, B.T-H. (46), Brush (4). Current taken from Ashton Corp. elec. works. [4-5]

Paisley and District Tramways Company, Elderslie, Paisley, and 74, Cheapside, London, E.C. *Manager*, F. Coutts; *Con. Eng.*, H. F. Parshall; *Secretary*, J. B. Glenn; *Directors*, Lord Arthur Butler, O. H. Smith, J. Johnston Smith.

E July, 1901; 14 mi. track; 4 ft. 7½ in. gauge. [6-5]

Peterborough Electric Traction Company, Ltd., The Depot, Lincoln Road, Peterborough, and Donington House, Norfolk Street, London, W.C. *Manager*, F. P. Comber; *Secretary*, C. H. Godward; *Chairman*, W. J. Greer; *Directors*, Lord Vaux of Harrowden and E. A. Paris.

E Jan., 1903; 5·33 mi. route; 6·71 mi. track; 3 ft. 6 in.; 94 lbs. G.; max. grad., 1 in 40; min. radius, 35 ft.; bracket and span wire; 0 wire; swivel trolley; contrs. overhead equip., J. G. White & Co.; feeders, W. T. Henley's; 14 d. deck 4-wheel cars; car bodies, Brush; motors, Brush 800 B., 17 h.p.; trucks, 4 wheeled Brush; current obtained from the Peterborough Corp. at 2d. per unit. [4-5]

Plymouth, Stonehouse and Devonport Tramways Company, 16, Edgcumbe Street, Stonehouse, Plymouth, and 74, Cheapside, London, E.C. *Manager*, G. H. Moreton; *Elec. Eng.*, J. Graham Pearce; *Sec.*, J. Barber Glenn; *Chairman*, Andrew Beattie; *Directors*, S. Hern (Managing), J. B. Glenn.

E Nov., 1901; 4·3 mi. route; 7 mi. track; 3 ft. 6 in.; 84 lb. G.; max. grad. 1 in 11; min. radius, 84 ft.; side poles; 0 wire; contrs. overhead equip., Blackwell & Co.; feeders, B.I.W.; 14 d. deck 4-wheel cars; car bodies, Dick, Kerr & Co.; motors, Dick, Kerr & Co., 33 N., 25 h.p.; trucks, Brill (21 E.); current taken from Corp. elec. works of Plymouth and Devonport. [9-4]

Poole and District Electric Traction Company, Poole, and Donington House, Norfolk Street, London, W.C. *Manager*, E. H. Mottram; *Per. Way Eng.*, E. A. Evans; *Secretary*, W. F. Cox, *Chairman*, E. Garcke; *Directors*, R. P. Simpson, P. G. Hamilton Carvill, M.P., W. M. Murphy, Dr. J. A. Hosker, G. F. M. Cornwallis-West.

E April, 1901; 3·75 mi. route; 4·5 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad., 1 in 13; min. radius, 45 ft.; side poles; 0 wire; swivel trolley; contrs. for overhead work, Macartney, McElroy & Co.; feeders, Callender's; 17 d. deck 4-wheel truck cars; car bodies, Brush, Dick, Kerr & Co., and Milnes; motors, B.T-H. 35 h.p. (GE. 58); trucks, Brill 21 E., and Brush. Current taken from Bournemouth and Poole Electric Supply Co. [4-5]

Portrush—Giant's Causeway Electric Tramway, Portrush. *Manager*, D. Fall; *Elec. Eng.*, W. A. Traill; *Chairman*, A. Traill; *Directors*, C. M'D. Stuart, J. S. Moore, W. A. Traill.

E September, 1883; 8 mi. route; 9 mi. track; 3 ft.; 42 lb. V.; 75 lb. G.; max. grad., 1 in 24; min. radius, 30 ft.; 4 motors; 22 cars; car bodies, Midland Wagon Co.; motors, B.T-H.; trucks, Peckham; generators, 2 E.C.C.

Potteries Electric Traction Company, Tramway Depôt, Stoke-on-Trent, and Donington House, Norfolk Street, London, W.C. *Gen. Manager and Eng.*, J. J. Walklate; *Elec. Eng.*, F. J. Chapple; *Assist. Manager*, F. Hatch; *Secretary*, W. F. Herring; *Chairman*, G. Cornwallis-West; *Directors*, E. Garcke, S. Mear, Sir Thos. Pilkington, Bart., J. V. Kitchener.

E May, 1899; 30·7 mi. route; 38·4 mi. track; 4 ft.; 87 G.; max. grad., 1 in 10; min. radius, 56 ft.; span wire and side pole; 0 wire; fixed trolley; contrs. overhead equip., R. W. Blackwell & Co., B.E.T. Co.; feeders, Callender's, Henley's, Johnson & Phillips'; 105 s. deck cars (69 with 4-wheel and 36 bogie trucks); car bodies, Brush, Dick, Kerr & Co., Midland Wagon Co.; motors, B.T-H. GE., 800, GE. 58, and Dick, Kerr & Co., 33 N., 25 and 35 h.p.; trucks, Brush, Peckham, Brill; generating cost, ·423d.; generators, 4 B.T-H., 2 Bruce Peebles, and 2 Helios; engines, 4, Browett & Lindley, 2, Ball & Wood, 2, McIntosh & Seymour, 1, Universal, 1, Willans, and 1, Sentinel; boilers, 8 Lancs., Tinker 5, and Danks 3; total, 2,160 kw. [4-5]

Rossendale Valley Tramways Company, Bacup Road, Rawtenstall, Lancs., and 61, Gracechurch Street, London, E.C. *Manager*, J. K. North; *Eng.*, G. Hopkins; *Sec.*, A. R. Abbott; *Chairman*, A. Love; *Directors*, W. P. Green, A. W. Owston, J. V. Kitchener, S. A. Sillem.

E January, 1899; 6·5 mi. route; 8 mi. track; 4 ft.; 90 lb. G.; max. grad., 1 in 14; min radius, 37 ft.; 12 d. deck cars; engines, T. Green & Son; boilers, T. Green & Son. [4-5]

Rothesay Tramway Company, Ltd., Pointhouse, Rothesay, and Donington House, Norfolk St., London, W.C. *Manager*, A. Robertson; *Resident Eng.*, A. Wilkes; *Sec.*, W. F. Herring; *Chairman*, Viscount Emlyn; *Directors*, F. B. Lea, A. C. Miles, C. S. B. Hilton.

E August, 1902; 4·81 mi. route; 9·62 mi. track; 3 ft. 6 in.; 94 lb. and 77 lb. G.; max. grad., 1 in 23; min. radius, 120 ft.; span wires; contrs. overhead equip., Dick, Kerr & Co.; feeders, Henley's; 20 s. deck bogie-truck cars; car bodies, Dick, Kerr & Co., and Brush; motors, Dick, Kerr & Co. and Brush Co; generators, Dick, Kerr & Co. 2 150 kw. and 1 50 kw.; engines, 2 Browett-Lindley and 1 Diesel; Tudor battery; boilers, 2 500 h.p. (total 350 kw.) [4-5

Ryde Pier Company, Ryde, Isle of Wight. *Manager*, W. D. Stanney; *Elec. Eng.*, C. Harrison; *Secretary*, L. Taylor; *Chairman*, W. M. Barnes.

E March, 1886; 0·5 mi. route (on pier); 1 mi. track; S.G.; 80 and 84 lbs. Vig.; 3 s. deck cars; car bodies, Lancs. Wagon Co.; motors, Siemens'; 2 Siemens' generators, 27 kw.; engines, 6 h.p. Otto 1, Stockport 1; total, 27 kw. [9-4]

Scarborough Tramways Company, Scalby Road, Scarborough. *Gen. Manager and Elec. Eng.*, J. E. Edmundson; *Secretary*, W. E. Nicoll; *Directors*, V. Fowler, M. Whittaker, J. Dale, J. C. Wigham, F. E. Gripper, W. B. Hopkins.

E May, 1904; 4·5 mi. route; 7·25 mi. track; 3 ft. 6 in.; 90 lb. & 91 lb. G.; max. grad., 1 in 11; min. radius, 35 ft.; bracket arm, span and centre pole; 00 wire; swivel trolley; contrs. overhead equip., Edmundson's Electricity Corp.; feeders, Callender's bitumen; 22 d. deck 4-wheel cars; car bodies, Brush Co. and B.E.C. Co.; motors, B.T.H. 35 h.p.; trucks, Brush Standard; Power supplied by the Scarborough Elec. Supply Co., Ltd., at 1·3d.; generators, 2 300 kw. Parsons' multipolar; engines, Parsons' 2 steam turbines; boilers, Lancs.; total 600 kw. tramway plant. [4-5]

Sheerness and District Electric Power and Traction Company, Sheerness East, and Surrey House, Victoria Embankment, London, W.C. *Manager & Eng.*, H. J. Nesbitt; *Sec.*, P. N. Gray. *Directors*, R. Hulme (*Chairman*), G. Offor, S. A. Sillem.

E April, 1903; 2·5 mi. route; 3 mi. track; 3 ft. 6 in. 94 lb. G.; min. radius, 45 ft; side poles; 00 wire; bow trolley; contrs. overhead equip., J. G. White & Co.; feeders, Callender's solid; 8 d. deck 4-wheel cars; car bodies, Brush; motors, Brush 50 h.p.; trucks, Brush; Current from own Power Station at a cost of 2d. per unit; generators, 3 Brush; engines, 3, Browett Lindley; boilers, 3, water-tube, B. & W. (total 120 kw.) [4-5]

Snaefell Mountain Railway (The Manx Electric Railway Company, 1, Strathallan Crescent, Douglas, Isle of Man). *Manager*, Harold Brown; *Resident Eng.*, F. Edmondson. *Sec.*, C. A. Huni; *Directors*, A. G. Kitching (*Chairman*), W. H. Vaudrey, B. E. Greenwell, E. Schenk, A. G. Boscawen.

E 1895; 4·5 mi. route; 9·25 mi. track; 3 ft. 6 in.; 56 lb. Vig.; max grad., 1 in 12; min. radius, 90 ft.; centre pole and span wire; 0 wire; feeders, Henley's and Callender's; 7 s. deck cars; car bodies, Milnes, & Co.; trucks, Milnes, Brush, and Brill; car equip., Mather and Platt; motors, Mather & Platt 25 h.p.; generators, 2 300 kw. Witting Eborall, 3 120 kw. D-C. E.C.C., 4 60 kw. Mather & Platt; engines, 3 430 h.p. Belliss & Morcom, 3 180 h.p. Robb Armstrong; boilers, 11, Galloway and B. R. Rowland & Co., and 1 120 h.p. (total, 1,300 kw.) [4-5]

(*Continued on page lii.*)

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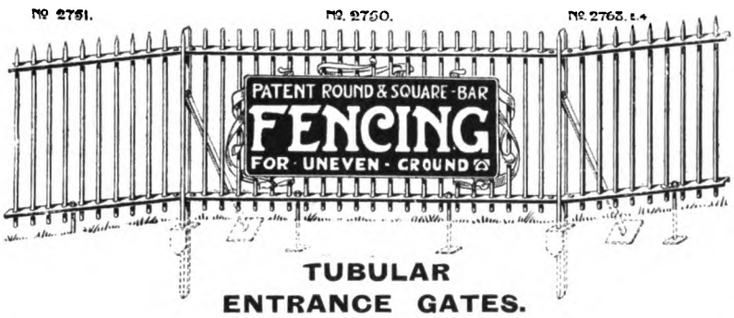

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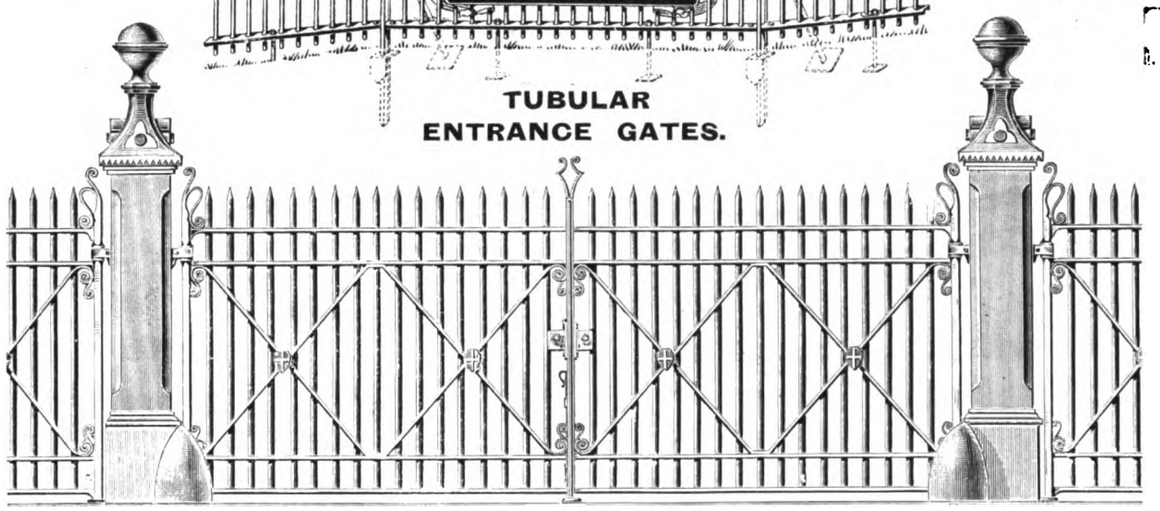

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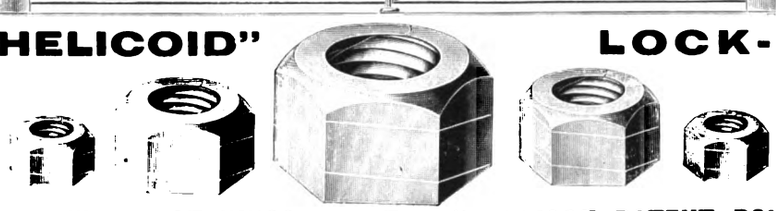

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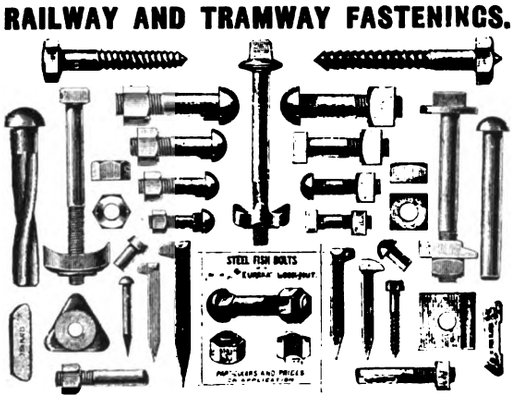

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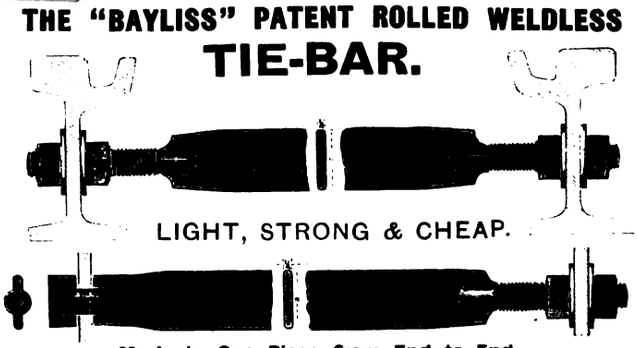

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ELECTRIC TRAMWAY AND RAILWAY DIRECTORY—*continued.*

South Lancashire Tramways Company, 9, North John Street, Liverpool. *Traffic Manager*, W. H. Lancaster; *Eng.-in-Chief*, J. R. Salter; *Resident Eng.*, E. H. Edwardes; *Sec.*, H. P. Conibear; *Chairman*, Hon. A. Stanley, M.P. *Directors*, E. K. Muspratt, C. E. Maples, E. Adam, J. Beecham, J. M. Henderson.

■ October, 1902; 19·375 mi. route; 25·375 mi. track; S.G.; 90 lbs. G.; max. grad., 1 in 15; min. radius, 50 ft; side poles; 00 wire; swivel trolley; contrs. overhead equip., R. W. Blackwell & Co.; feeders, B.I.W.; 45 d. deck 4-wheel cars; car bodies, Milnes & Co.; trucks, Milnes & Co.; motors, Witting Eborall 30 h.p.; generators, 1 500 volt. Witting Eborall A.C., 3 250 volt 2-phase 50 cycle, 1 500 volt. motor generator; engines, Witting Eborall, slow speed comp.; boilers, 4 Lancs. Yates & Thom; (total 2,000 kw.) [4-5]

Southport Tramway Company, Ltd., Southport and Donington House, Norfolk Street, London, W.C. *Manager*, J. Lloyd; *Secretary*, S. N. Wells; *Chairman*, J. S. Isworth. *Directors*, J. Platt, Lord Vaux of Harrowden, J. V. Kitchener.

■ July, 1901; 9·121 mi. route; 9·78 mi. track; S.G.; 87 G.; no gradient; min. radius, 40 ft.; side pole; 00 wire; swivel trolley; contrs. overhead equip., Southport Corporation; feeders, Callenders; 20 d. deck and 1 s. deck 4-wheel cars; car bodies, Brush; motors, Brush 17 h.p.; trucks, Brush. Current from Southport Corporation Trys. and Birkdale and District Elec. Supply Co., 2d. per unit. [4-5]

South Staffordshire Tramways (Lessee) Company, Tramway Depot, Darlaston. *Managing Eng.*, H. Hartley; *Traffic Manager*, R. W. Cramp; *Elec. Eng.*, F. J. Smith; *Secretary*, W. F. Cox; *Chairman*, E. Garcke. *Directors*, Jas. Lycett (*Managing*), S. R. Blundstone, W. S. Schuster, Sir E. Spencer.

■ ; 18·98 mi. route; 29·50 mi. track; 3 ft. 6in.; 97 & 90 lb. G.; max. grad., 1 in 17; min. radius, 46 ft.; side brackets, span wire, and centre pole; 0 and 000 wire; swivel trolley; contrs. overhead equip., E.C.C., and B.I.W.; feeders, B.I.W. and Callender's, armoured; 46 d. deck cars (18 with bogie and 28 with 4-wheel trucks); car bodies, Brush, Brown Marshalls, and Lancaster Carriage Co.; trucks, Brush, Brill, E.C.C., and Baltimore; motors, B.T-H. E.C.C., and Brush 1,000 B. Current obtained from own station and West Bromwich Corporations at 2d. per unit. Generators, 3 E.C.C.; engines, 3 Musgrave and Son, H.Cp.C. 125 h.p. each; boilers, 3 Lancs., Musgrave and Son; total, 273 kw. [4-5]

Sutton and Howth Electric Tramway Company (owned by the Great Northern Railway, Ireland), Sutton, county Dublin, and Amiens Street Terminus, Dublin. *Gen. Manager*, Lieut. Col. H. Plews; *Elec. Eng.*, A. W. Whieldon; *Supt. of Line*, R. J. Moore; *Eng.-in-Chief*, W. H. Mills; *Sec.*, T. Morrison; *Chairman*, W. Quartus Ewart, Bart.; *Directors*, L. O. Hutton, *Deputy Chairman*, Col. L. M. Buchanan, W. P. Cairnes, J. H. Carson, F. Coates, H. S. Guinness, J. Jameson, J. Malcolm, J. T. Reade, F. Vernon, R. A. Gradwell.

■ June, 1901; 5·75 mi. route; 6·75 mi. track; 5 ft. 3 in.; 72 lb. bull headed; max. grad., 1 in 16·7; min. radius, 300 ft.; side poles with short bracket arms; 0000 wire; swivel trolley; contrs. overhead equip., Dick, Kerr & Co.; feeders, lead covered, B.I.W.; 10 d. deck bogie cars (also 1 goods car with bogie truck); car bodies, Milnes & Brush; motors, 18-37 h.p. Westinghouse and 4 40 h.p. B.T-H.; trucks, Brill & Peckham, max. traction; generators, 3 D-C. 250-h.p. Scott & Mountain; engines, 3 comp. Scott & Mountain; boilers, 3 Lancs. 300-h.p. each, Taylor; total 550 kw. [4-5]

Swansea Improvements and Tramways Company, 2, Rutland St., Swansea, and Donington House, Norfolk Street, London, W.C. *Gen. Manager*, D. James; *Secretary*, H. A. Stagg; *Chairman*, C. G. Tegetmeier; *Directors*, G. R. Hulme, W. G. Bond.

■ June, 1900; 5·5 mi. route, 8·5 mi. track; S.G.; 86 lb. G.; max. grad., 1 in 22; min. radius, 40 ft.; span wires, side and centre poles; feeders, Callender's; 19 d. and 36 s. deck cars; car bodies, Brush; motors, 35 h.p. 22—GE. 52, 30 Westinghouse, Railway 46—36.—800A Brush; trucks, max. traction, Peckham and Lord Baltimore; generators, 2 Westinghouse 200 kw. 1 G.E. 200 kw., 1 Byng-Hawkins motor generator; engines, 3 Ball & Wood, 1, Alley and McLellan; boilers, 3, water-tube, B. & W.; total 750 kw. [4-5]

Taunton, West Somerset, Electric Railways and Tramways Company, Ltd., East Reach, Taunton, and Donington House, Norfolk Street, London, W.C. *Manager*, W. Smith; *Elec. Eng.*, C. J. Wharton; *Secretary*, P. N. Gray; *Chairman*, W. G. Bond; *Directors*, S. R. Hulme, A. Goodman.

■ Aug., 1901; 1·25 mi. route; 1·5 mi. track; 3 ft. 6 in.; 90 lb. G; max. grad., 1 in 25; min. radius, 40 ft.; side pole; 00 wire; swivel trolley; contrs. for overhead equip., R. W. Blackwell and Co.; feeders, Callender's; 6 d. deck 4-wheel cars; car bodies, Brush; motors, Brush (800 B.) 17 h.p.; trucks, Brush. Current obtained from the Taunton Corp. at 2d. per unit. sliding scale. [4-5]

Trafford Park Estates, Ltd. (Tramways and Lighting), Trafford Park, and 18, Exchange Street, Manchester. *Resident Estate Manager*, W. H. Gaunt; *Secretary*, Geo. Mellors; *Chairman*, Col. Paget Mosley; *Managing Director*, Marshall Stevens; *Directors*: J. Lyons, M. Praed, Sir W. H. Bailey.

■ July, 1903; 2·5 mi. route; 3 mi. track; S.G.; 98 lb. G; no gradient; min. radius, 35 ft.; span wire, bracket poles; 00 wire; swivel trolley; overhead equip., W. T. Glover & Co.; feeders, Glover's; 7 d. deck cars, 5 with 4-wheel and 1 bogie truck and 6 trailers; car bodies, British Elec. Car Co.; motors, Westinghouse, 49 B 35 h.p.; trucks, British Elec. Car. Current obtained from the Trafford Park Power and Lighting Supply station; generators, 2 D-C. Mather & Platt, 1 Allegem. Gesellschaft, 1 Lancs. Dy. Co.; tramway motor generator, Mavor and Coulson; engines, 2 Raworth compound tand. and 2 Browett Lindley; boilers, 3 B. & W. and 1 Tinker. [4-5]

Trafford Park Light Railways, Trafford Park, Manchester.

5 mi. route; 7 mi. track; gradient, 1 in 100; min. radius, 200 ft. Constructed and worked under West Manchester Lt. Rys. Order. [4-5]

Tynemouth and District Electric Traction Company, Limited, John Street, Cullercoats, Northumberland, & Donington House, Norfolk Street, W.C. *Manager*, R. Simpson; *Elec. Eng.*, W. H. Moorhouse; *Sec.*, S. N. Wells; *Chairman*, W. J. Greer. *Directors*, J. H. Robinson, J. B. Williamson, H. S. Day.

■ March, 1901; 4·25 mi. route; 7·3 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad., 1 in 10; min. radius, 30 ft.; side poles; 00 wire; swivel trolley; contrs. overhead equip., Blackwell & Co., and Brush Co.; feeders, B.I.W. and Henleys; 21 d. and 18. deck cars; car bodies, Dick, Kerr; trucks, Brill and Baltimore; motors, B.T-H. Dick, Kerr (33 N.) 35 h.p. Current taken from Tynemouth Corp. Station at 1½d. to 1d. per unit (sliding scale); generators, 1 Westinghouse 6 pole, and 2 Holmes & Co. 4 pole; engines, 3 Belliss & Morcom D.C.; boilers, 4 Lancs. Yates & Thom; total, 360 kw. [4-5]

Tyneside Tramways and Tramroad Company, Ltd., Neptune Bank, Wallsend. *Manager*, W. McLellan; *Resident Eng.*, F. C. Kidman; *Secretary*, J. C. Little; *Chairman*, The Right Hon. Lord Armstrong; *Directors*, J. T. Merz, J. W. Armstrong, G. E. Henderson, S. Hunter, J. H. B. Noble.

■ Sept., 1902; 8·91 mi. route; 12·66 mi. track; S.G.; 95 lb. G.; max. grad., 1 in 10; min. radius, 40 ft.; span wire and side poles; 0.0 wire; swivel trolley; contrs. for overhead work, Dick, Kerr & Co.; feeders, Callender's; 21 d. deck cars (18 4-wheel and 6 bogie); car bodies, Milnes & Co. and Brush Co.; motors, Westinghouse No. 50 40 h.p.; trucks, Brill. Current taken from Newcastle Electric Supply Co. and Tynemouth Corp. at 1½d. per unit. [4-5]

Wakefield and District Light Railway Company, Belle Isle, Wakefield. *Gen. Manager*, H. England; *Traffic Supt.*, T. Tate; *Elec. Eng.*, C. E. Davies; *Secretary*, W. H. Andrews; *Chairman*, H. S. Leon, J. P.; *Directors*, E. Schenk, A. G. Kitchen.

■ August, 1904; 15·139 mi. route; 24·723 mi. track; S.G.; 96 lb. G.; max grad., 1 in 15·6; min. radius, 36 ft.; side bracket; 00 wire; swivel trolley; contrs. overhead equip., Dick, Kerr & Co.; feeders, Glover & Co.; 55 d. deck 4-wheel cars; car bodies, Dick, Kerr & Co.; motors, Dick, Kerr 25A; trucks, Brill 21E; generators, 3 three-phase, Dick, Kerr; engines, 3, Howden (Glasgow), high-speed; boilers, 4 Lancs., Spurr, Inman, & Co.; total, 1,200 kw. [9-4]

Walton-on-the-Naze Pier Tramway (Coast Development Co.), Walton-on-the-Naze. *Manager and Elec. Eng.*, M. Packer; *Sec.*, J. F. Stovell; *Chairman*, G. Riley; *Director*, H. R. Spence.

■ August, 1898; 0·5 mi. route; 0·5 mi. track; 3 ft. 6 in.; 36 lb. V.; third rail; feeders, Glover's; 3 s. deck cars (3 trailer cars); motors, T. Parker, Ltd., and Compton & Co., 8 and 12 h.p.; generators, 1 2-pole and 1 4-pole; Parker's engines, 1 Sharps, high-speed vert., and 1 Peache 3-cylinder boiler, 1 loco. and 1 Cornish Danks (total 25 kw.) [6-4]

West Riding of Yorkshire Tramways. (Included in system of Wakefield and District Light Railway).

Weston-super-Mare Tramway Company, Locking Road, Weston-Super-Mare, and Donington House, Norfolk Street, London, W.C. *Manager & Elec. Eng.*, M. Nash; *Sec.*, C. H. Godward; *Chairman*, G. R. Hulme; *Directors*, G. Offor and G. J. Somerville.

■ May, 1902; 2·9 mi. route; 3·5 mi. track; S.G. 90 lb. G.; max. grad., 1 in 25; min. radius 40 ft.; span wire and side poles; 00 wire; swivel trolley; contrs. overhead equip., Blackwell & Co.; feeders, Callender's; 8 d. and 4 s. deck 4-wheel cars (total 12); car bodies, Brush; motors, B.T-H. 20 h.p.; trucks, Brill; generators, 3 Brush multipolar and 1 Siemens; engines, 2 Brush, Universal, 2 Browett & Lindley comp.; boilers, 5 B. & W.; total 800 kw. [4-5]

Wolverhampton District Electric Tramways, Limited, Central House, Birmingham, & Donington House, Norfolk Street, London, W.C. *Engineering Manager*, G. Conaty; *Traffic Manager*, R. W. Cramp; *Eng.*, R. N. Tweedy; *Sec.*, P. N. Gray; *Assist. Sec.*, B. Kingsford; *Chairman*, C. S. B. Hilton; *Directors*, S. R. Blundstone, J. A. Lycett.

■ April, 1900; 14·75 mi. route; 19 mi. track; 3 ft. 6 in.; 90 lb. G.; max. grad., 1 in 20; min. radius, 40 ft.; side trolley and bracket arm; fixed and swivel trolleys; contrs. for overhead equip., J. G. White & Co., and G. Law; feeders, B.I.W.; 30 d. deck cars (21 bogie and 9 4-wheel trucks); car bodies, Brush & Co. and Milnes; trucks, Brush, Brill; motors, B.T-H. 18 h.p.; current obtained from the Dudley Corp. elec. works; generators, 4 Westinghouse 8-pole (total 1,200 kw.), and from the Midland Electric Corporation. [4-5]

Worcester Electric Traction Company, St. John's, Worcester, and Donington House, Norfolk Street, London, W.C. *Manager*, R. R. Fairbairn; *Secretary*, H. A. Stagg; *Chairman*, H. S. Day; *Directors*, J. A. Lycett, W. G. Bond, H. R. Arnold.

■ Feb., 1904; 5·75 mi. route; 8·25 mi. track; 3 ft. 6 in.; 94 lb. G.; max. grad. 1 in 13; min. radius 45 ft.; span and side pole; 0 wire; swivel trolley; contrs. overhead equip., Brush Elec. Eng. Co.; feeders, Western Elec. Co.; 15 d. deck 4-wheel cars; car bodies, Brush Co.; motors, Dick, Kerr, & Co.; trucks, Brush Co; current from Corporation Elec. Works; generators, Bruce, Peebles, & Co.; engines, 3 Belliss; boilers, B. & W. [4-5]

Wrexham and District Electric Tramways Limited. Tramway Depot, Johnstown, Ruabon, N.W., and Donington House, Norfolk Street, London, W.C. *Manager*, G. W. King; *Sec.* W. S. Wreathall; *Chairman*, G. F. M. Cornwallis-West; *Directors*, E. Hopwood, J. F. Albright.

■ April, 1903; 4 mi. route; 4·38 mi. track; 3 ft. 6 in.; 97 lb. G.; max grad., 1 in 9; min. radius, 47 ft.; side pole and span wire; 0 wire; swivel trolley; contrs. overhead equip., British Elec. Traction Co.; feeders, B.I.W., solid; 10 d. deck 4-wheel truck cars; car bodies, Brush; motors, B.T-H., 35 h.p.; trucks, Brush; current obtained from the Wrexham Corp. elec. works at 2d. per unit; generators, The Lancashire Dynamo Co., multipolar; engines, Willans, central valve; boilers, B. & W.; total 675 kw. [4-5]

Yorkshire Electric Tramways Construction Syndicate, Limited, 14, Victoria Street, London, S.W. *Gen. Manager*, H. England; *Elec. Eng.*, C. E. Davies; *Cons. Eng.*, B. V. D. Cooper (22, Buckingham Gate, S.W.); *Secretary*, W. H. Andrews; *Chairman*, H. S. Leon; *Directors*, A. G. Kitching, E. Schenk, G. E. Leon.

[See Wakefield and District Light Railway Co., which operates lines owned by the above Syndicate.]

Yorkshire (Woollen District) Electric Tramways, Limited, Donington House, Norfolk Street, London, W.C. *Traffic Manager*, L. Johnston; *Elec Eng.*, R. C. Goldston; *Per. Way Eng.*, R. J. Howley; *Sec.*, S. Humphry; *Directors*, E. Garcke (*chairman*), Sir Thomas Pilkington, W. J. Greer, J. S. Raworth, E. A. Harris (*managing*).

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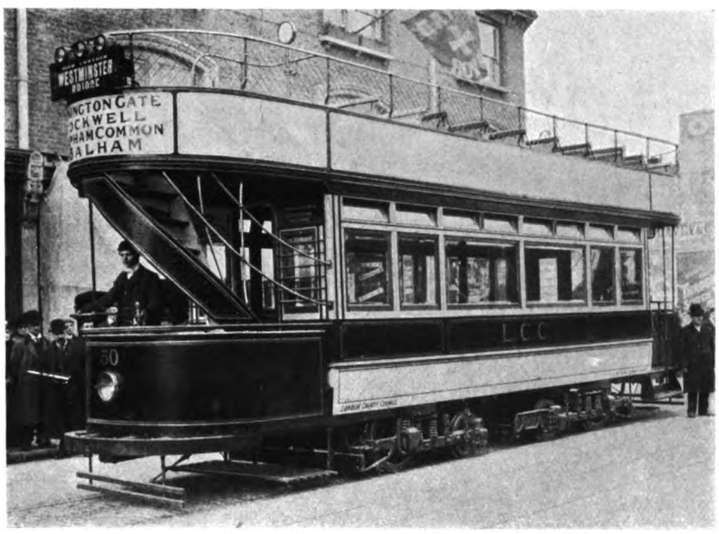

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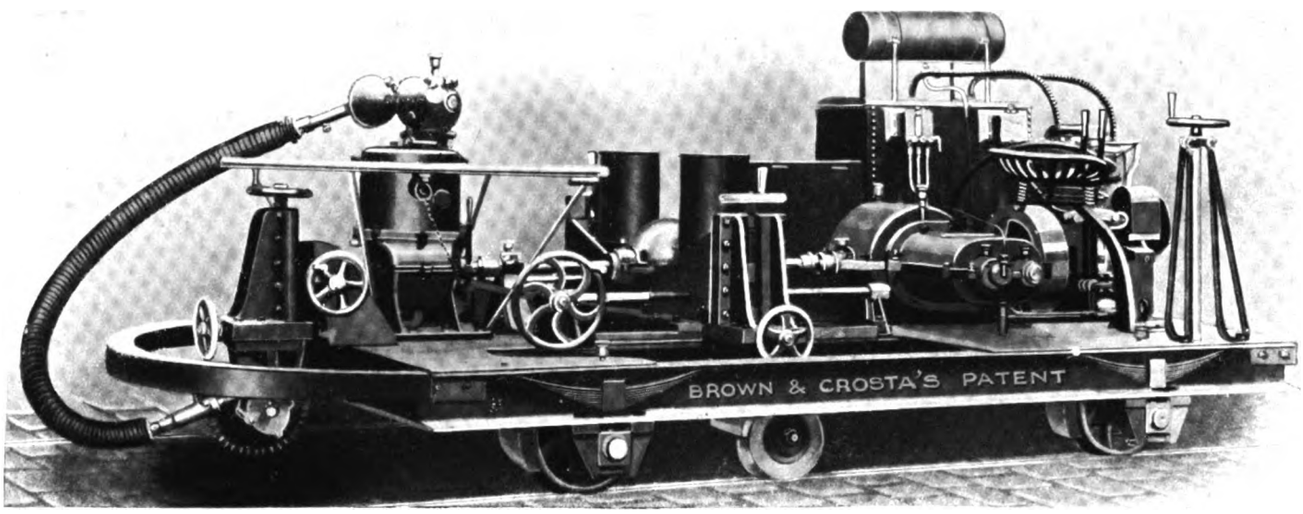

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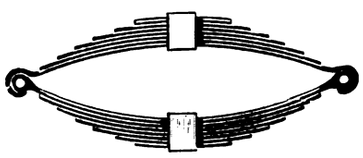

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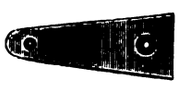

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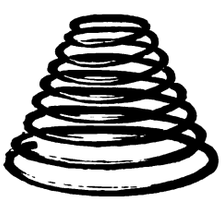

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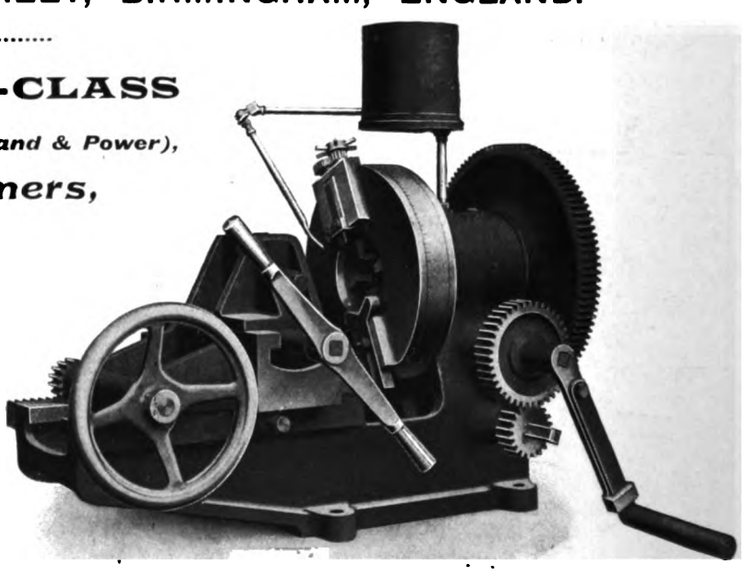

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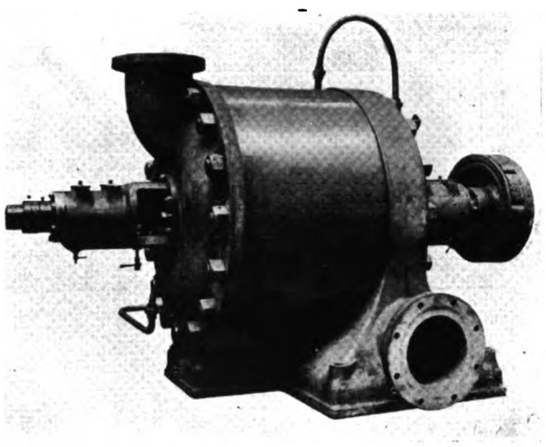

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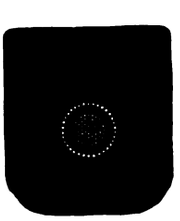

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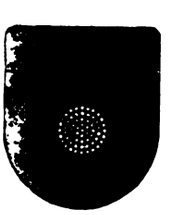

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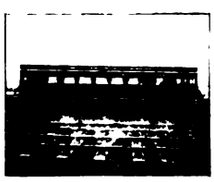

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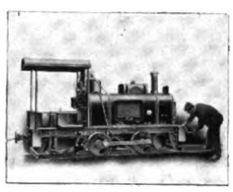

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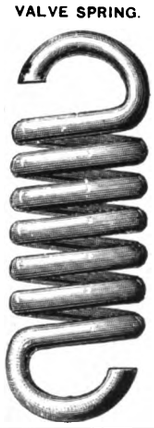

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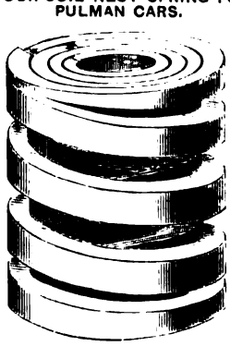

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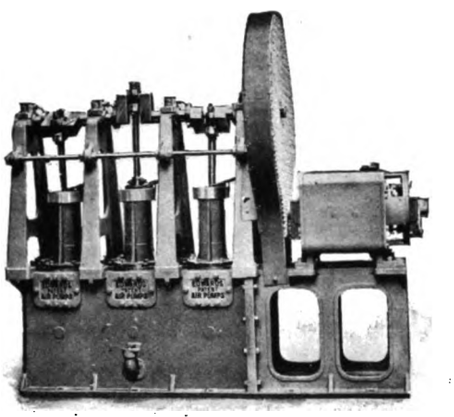

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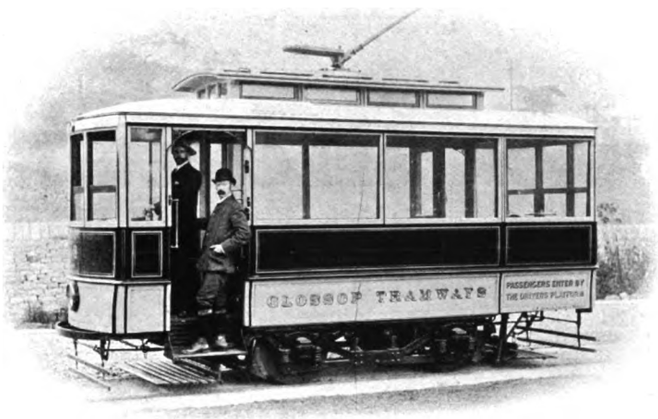

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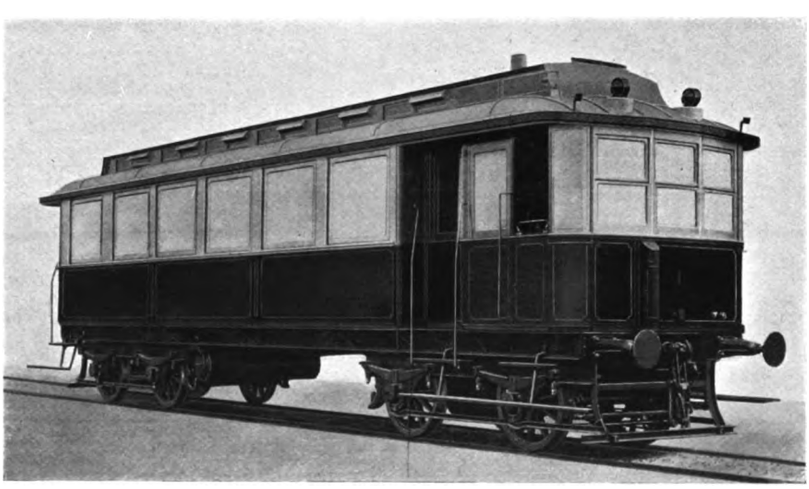

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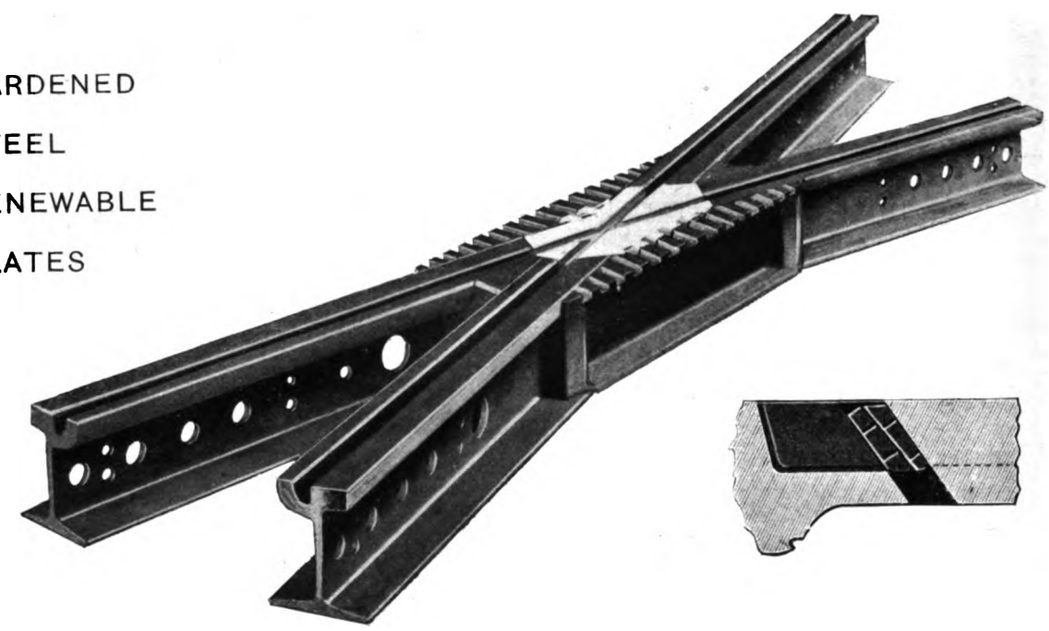

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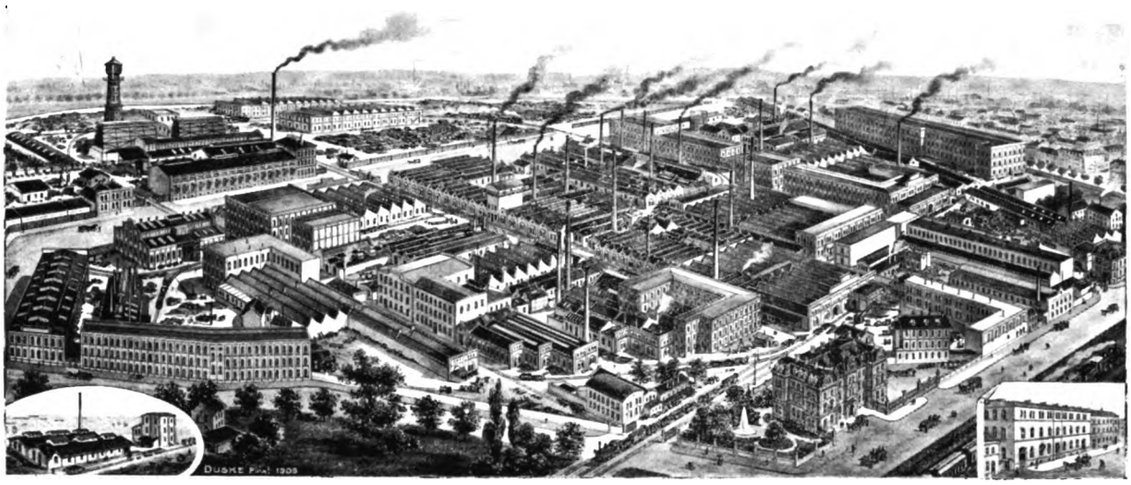

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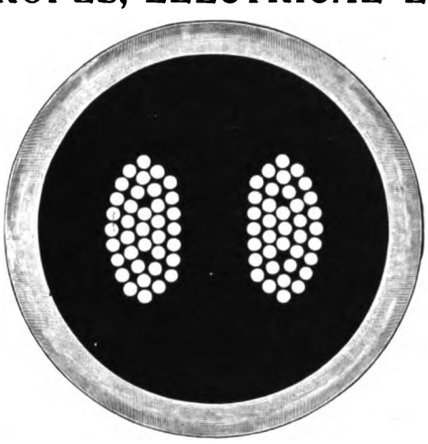

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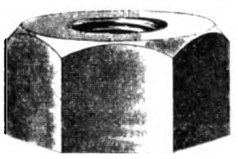

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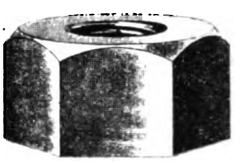

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A comprehensive Catalogue of the Exhibition will be ready on July 3rd.

The Catalogue will contain succinct descriptions of all exhibits, a carefully compiled classification of all exhibits, enabling visitors to ascertain at a glance at what stands any particular kind of apparatus or material is shown.

Blank pages will be provided for visitors' notes, and a clearly drawn plan of the exhibition will be included.

The Catalogue will be well printed on good paper, and will form a useful and attractive souvenir of the Exhibition.

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July 3rd to July 14th, 1905.

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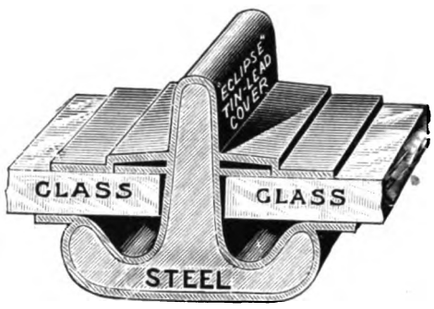

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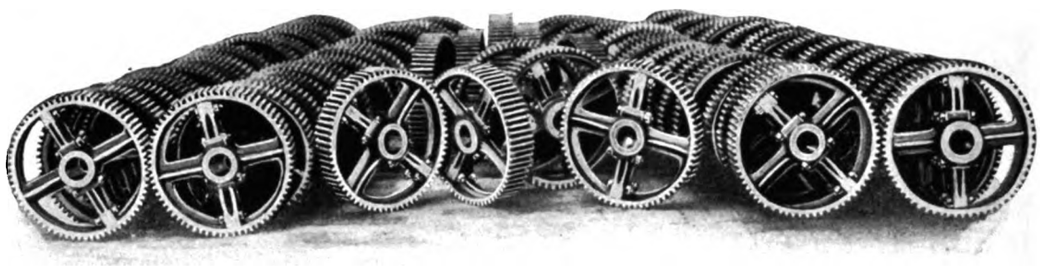

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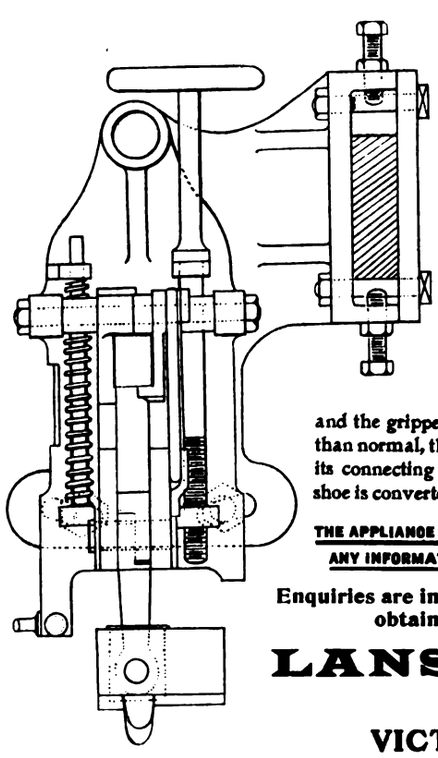

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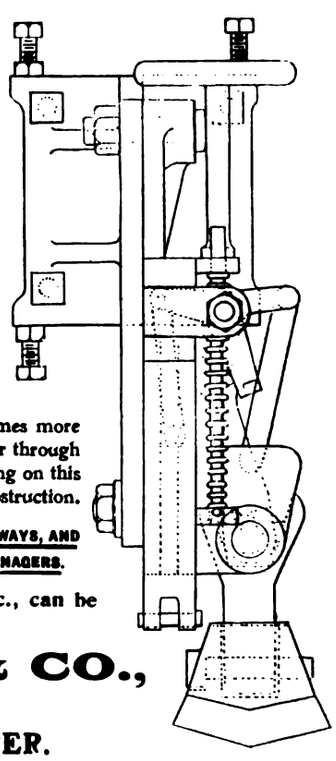

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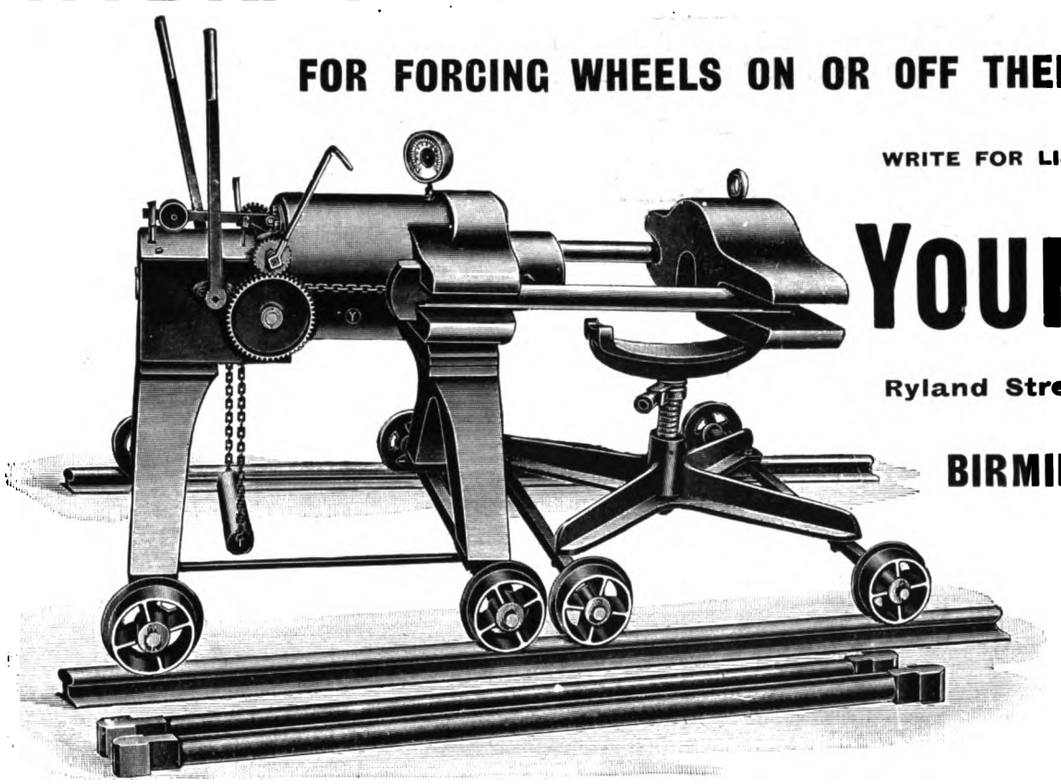

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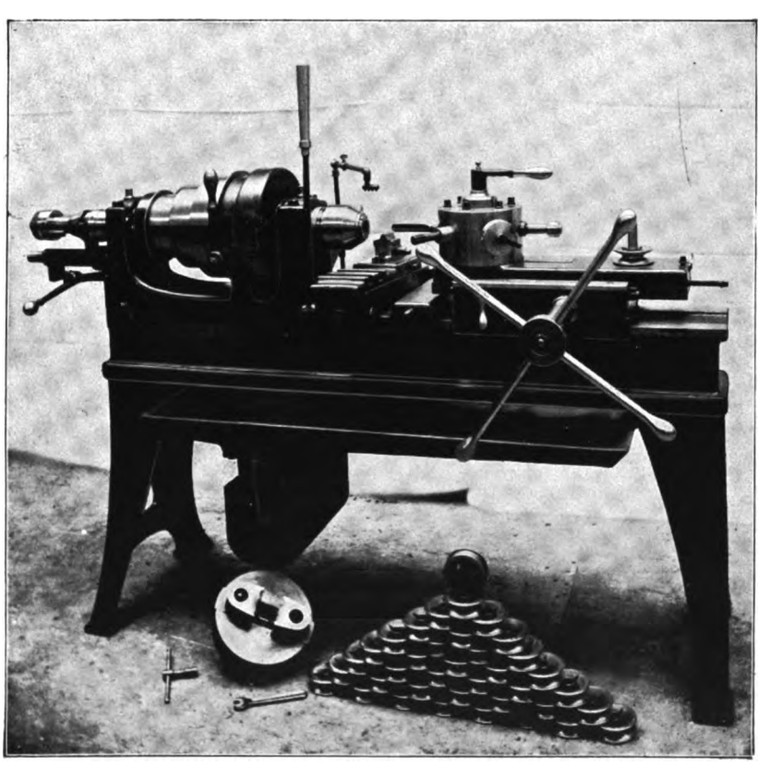

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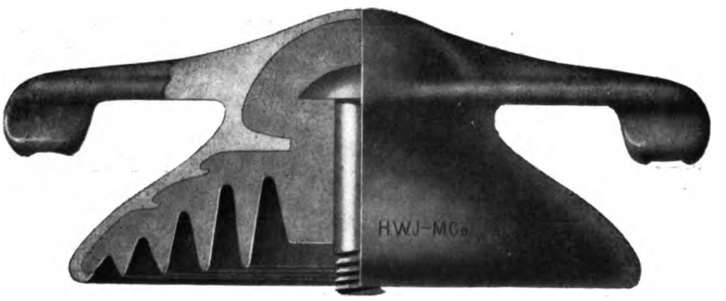

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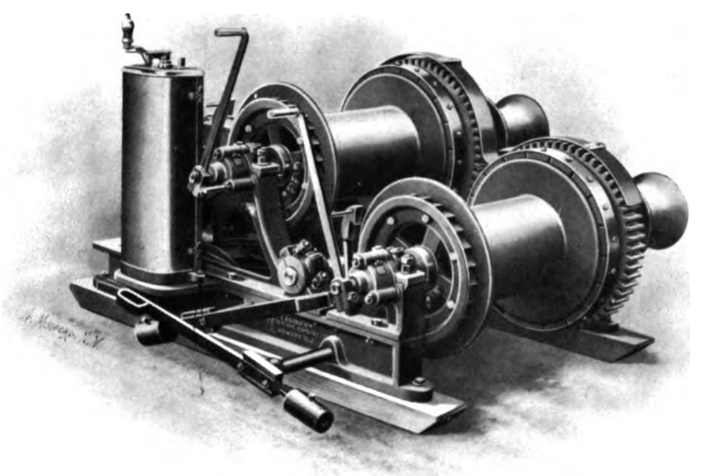

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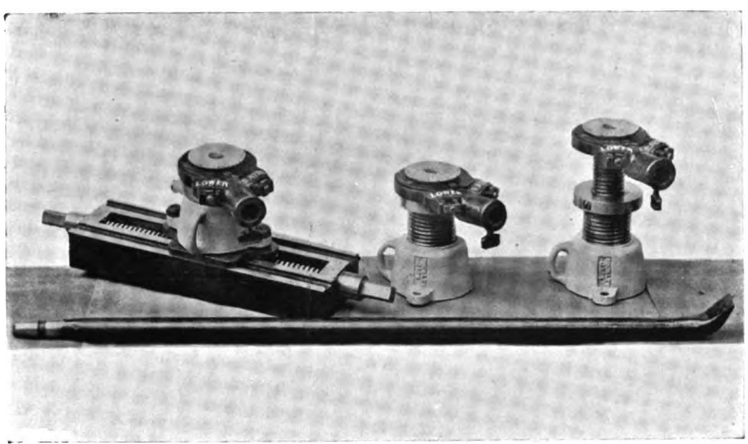

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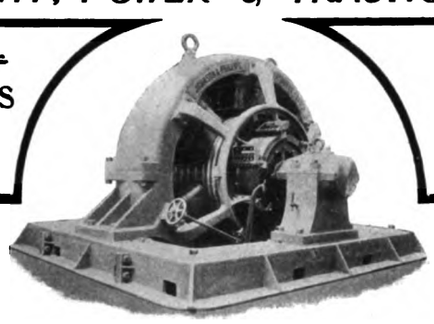

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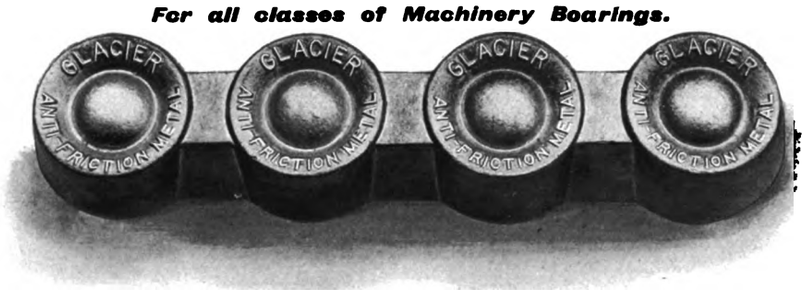

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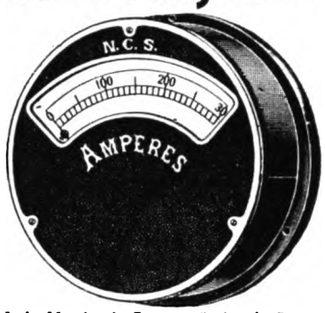

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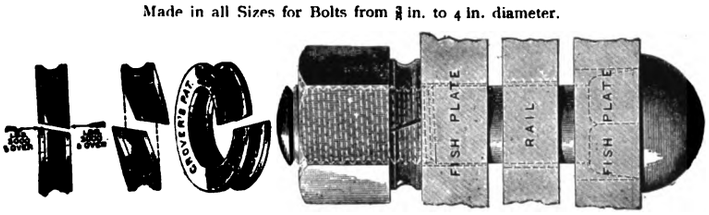

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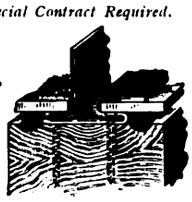

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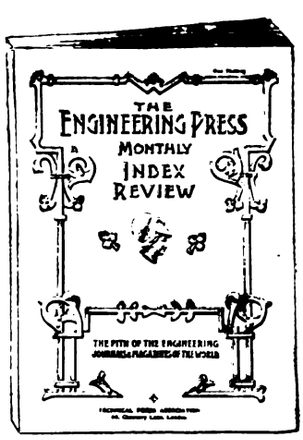

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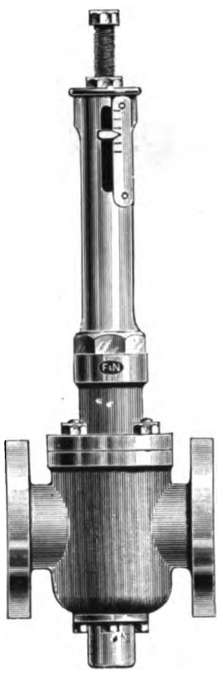

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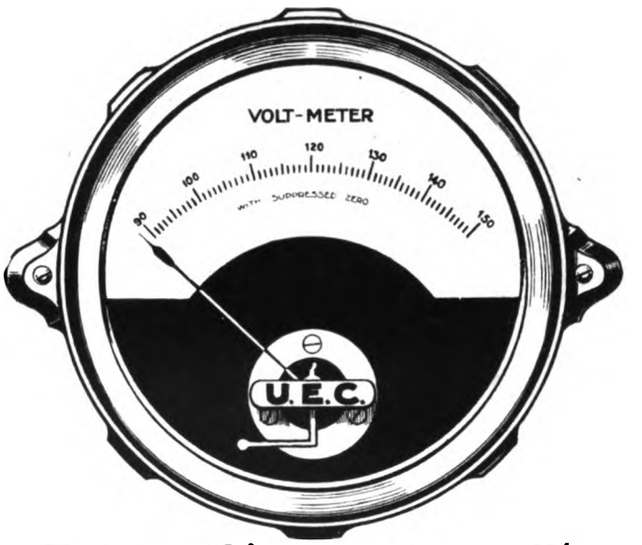

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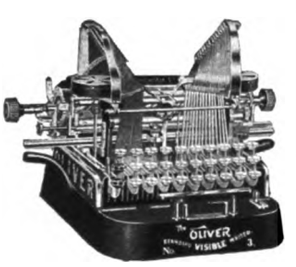

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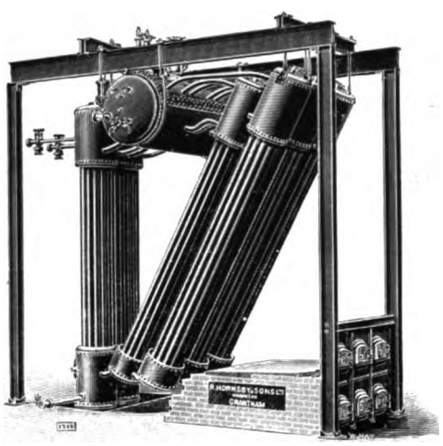

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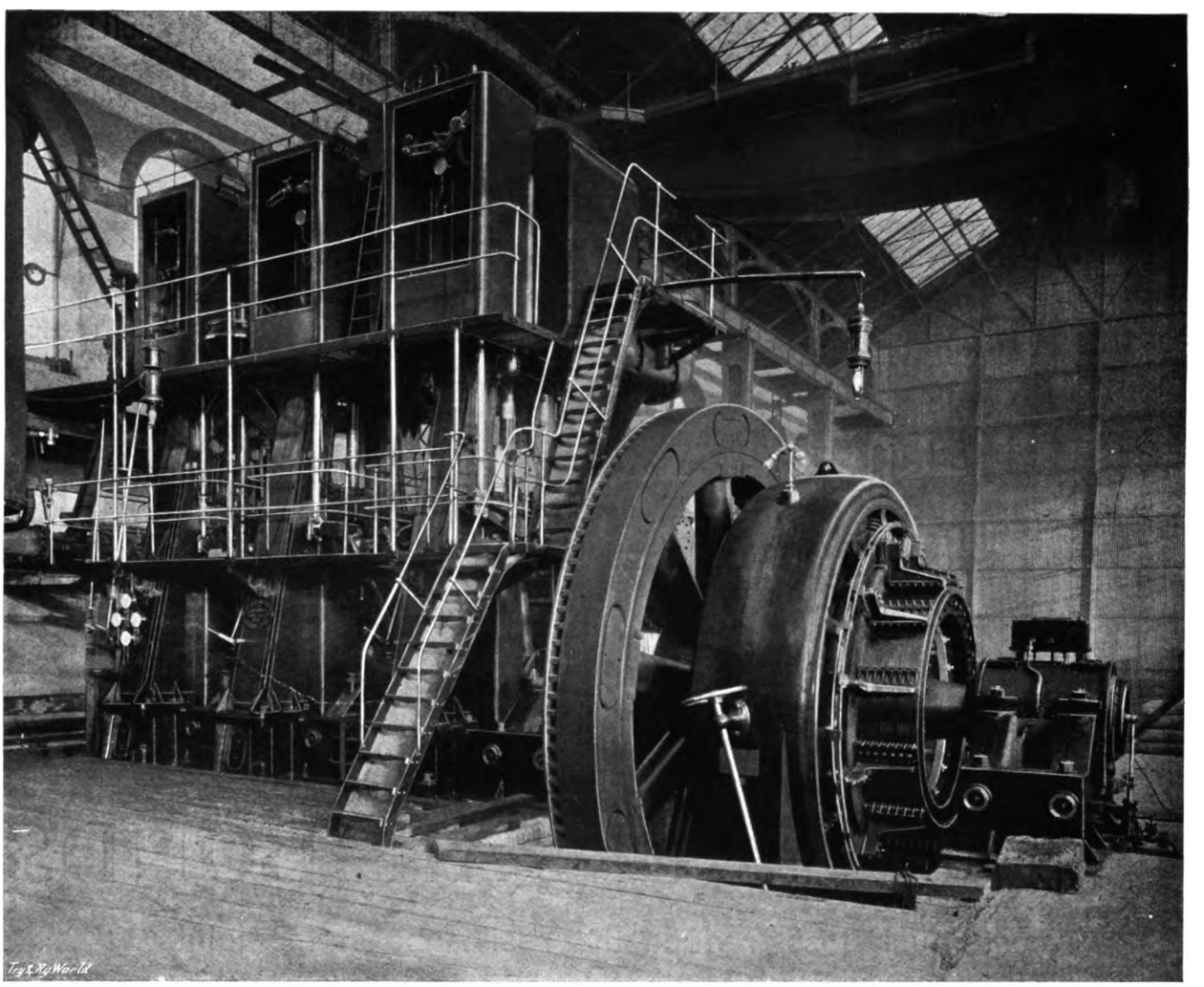

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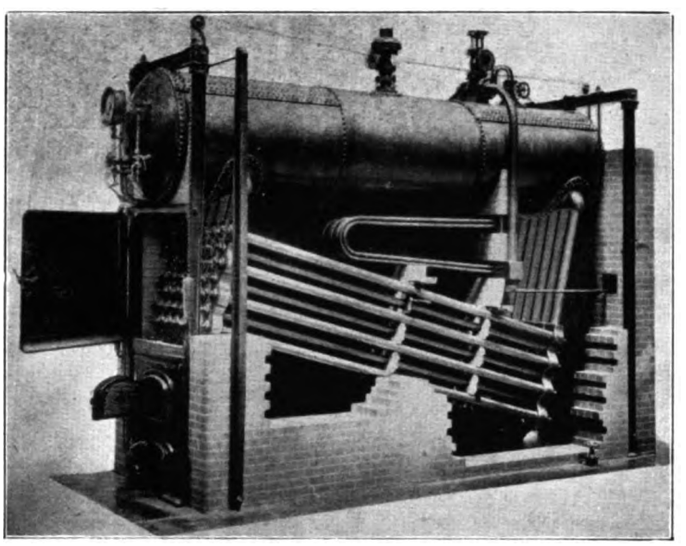

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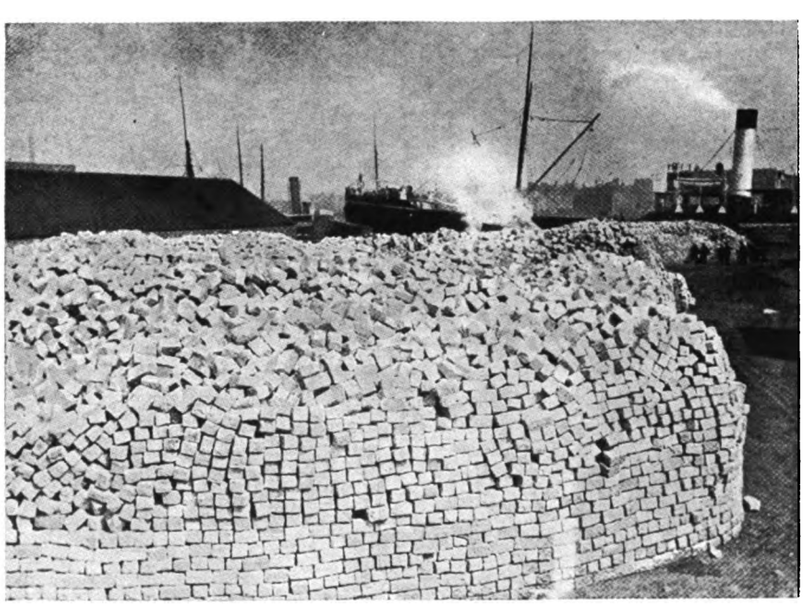

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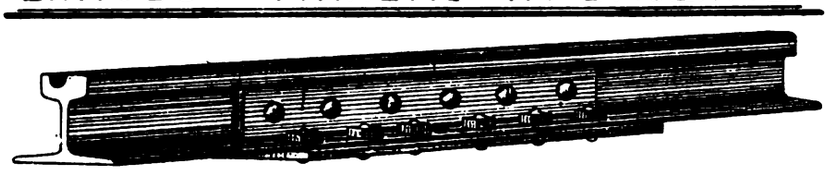

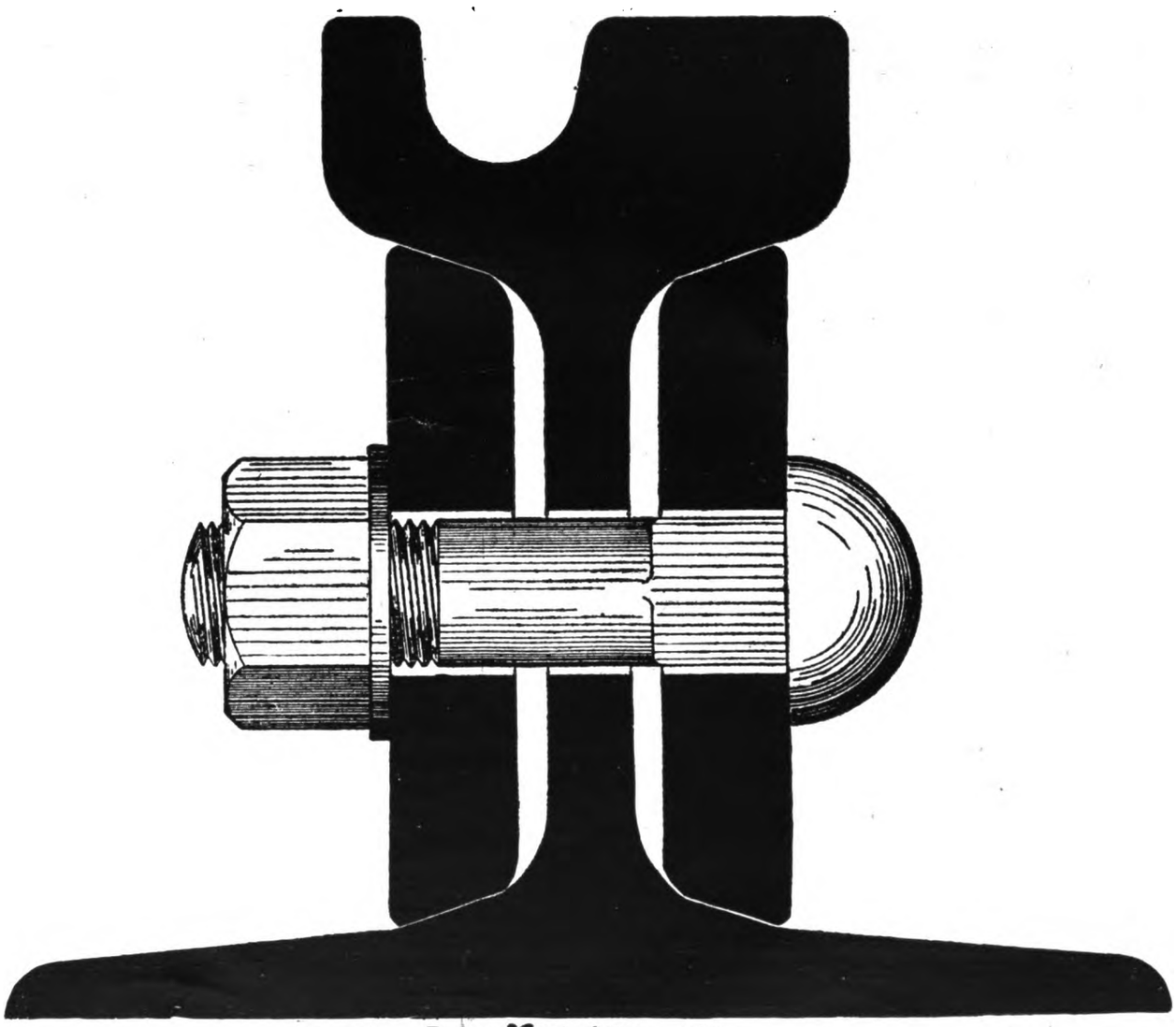

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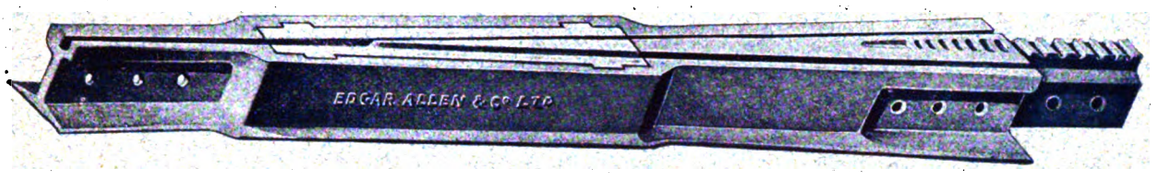

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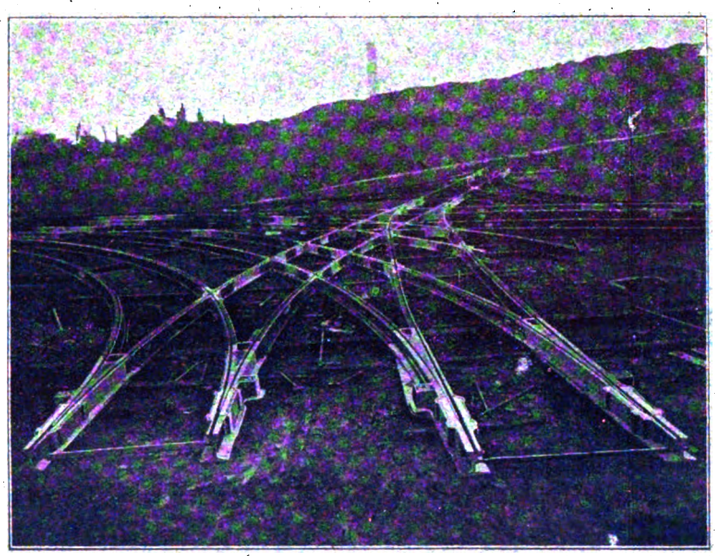
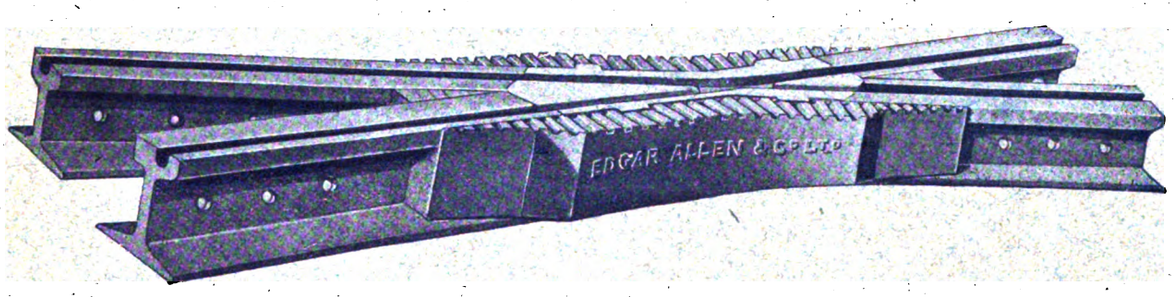


POINTS and CROSSINGS IN **ALLEN'S** IMPERIAL **MANGANESE,** or TOUGHENED CAST STEEL, with RENEWABLE INSETS, IRON BOUND POINTS and CROSSINGS.



We invite Tramway Engineers to visit our Stand (No. 118) at the Tramway Exhibition, Agricultural Hall, London, July 3 to 14, and see the exhibits of Special Points in Manganese Steel, &c, Connected Automatic and Movable Points, Drain Boxes, Tie Bars, General Tools, &c., &c.

SHEFFIELD.

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